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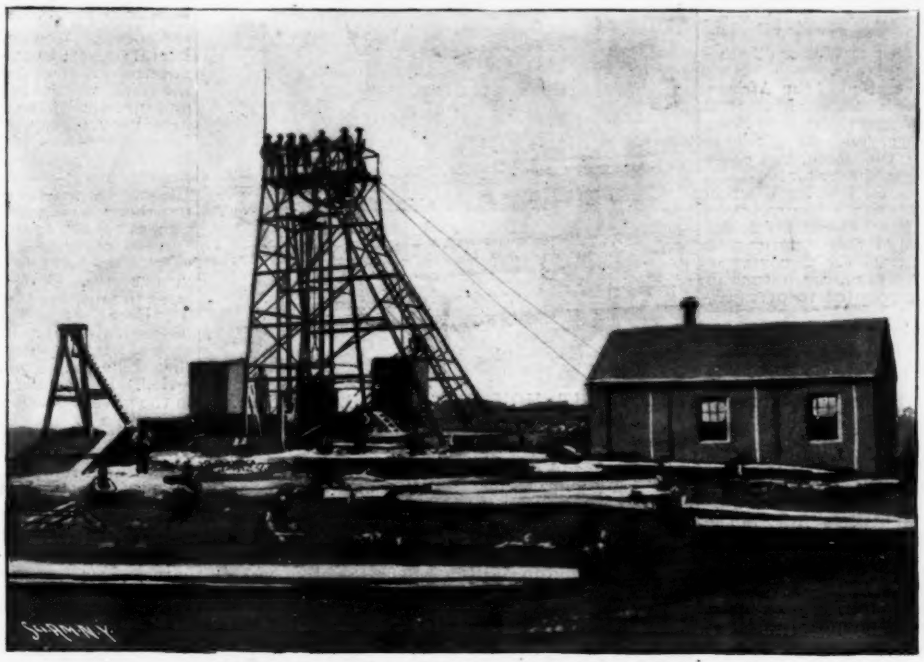
THE TRANSVAAL.

THE startling events which marked the close of the year 1895 and the opening of the new year will be memorable in the history of the Transvaal, not merely as permanently affecting the internal affairs of that country, but as serving to awaken throughout the world at large an interest in the history and present state of the republic as profound as it was widespread. If nothing ever came of such burning questions as the boundary line dispute in Venezuela or the political aspirations of the Uitlanders in the land of the Boers, other than the general enlightenment regarding such countries which quickly takes place, these troubles would have served a useful purpose.

Natural Features.—The Transvaal takes its name from the Vaal River, which separates it from the Orange Free State and Natal to the south. On the north and northwest it is bounded by the Limpopo River, beyond which lies the Matebeleland, of which Dr. Jameson was lately administrator. To the west lies the British protectorate of Bechuanaland, from which it is separated partly by the Marico and the Hart Rivers and partly by an imaginary line. The Limbomba Mountains to the east separate it from the Portuguese Colonies and Zululand. The country lies approximately four square, and measures about 425 miles north and south by 400 miles east and west.



HEADGEAR OF A TRANSVAAL GOLD MINE.

The population, including aborigines, is calculated to be from 375,000 to 400,000. In its physical characteristics the Transvaal may be described as a lofty tableland, slightly hollowed or "dished" in the center; and, as such, it forms a portion of the great South African plateau. Its mean altitude above sea level is 3,000 feet. To the south and east this basin is walled in by a mountainous range, which in places reaches a height of 10,000 feet. From this elevation the country falls away precipitously toward the Libomba Mountains, which, with an altitude of 2,000 feet, form the eastern

A TROOP OF BOERS ADVANCING TO MEET DR. JAMESON.

boundary of the state. The Limpopo or Crocodile River, to the north, is navigable for 340 miles from its mouth, or as far as its junction with the Limouba. This river, and the Vaal to the south, form the chief system of drainage for the country; there are also numerous drainage lagoons or "salt pans" to be found in the western and northern districts.

The climate is salubrious, and, although the country lies partly within the tropics, the air, as a result of the great elevation, is invigorating. The dryness of the air in the western and central portions of the country renders it specially favorable to patients suffering from consumption.

The marsh lands that border the rivers, however, are extremely unhealthy, and breed the well known African fever. There is a rainy or summer season, lasting from October till the following April, succeeded by a dry winter season. The rainfall is unevenly distributed. The moisture that is carried inland from the Indian Ocean is most of it precipitated by the abovementioned range of the Drakenberg Mountains and the high lands of Eastern Transvaal.

The mean annual temperature is over 68° F., varying between 40° in June and 90° and 95° in January. The rainfall ranges from 12 inches in Western Transvaal to 60 inches on the eastern uplands.

Mineral Wealth.—There is no section of the African continent which can compare for a moment in mineral wealth with the Transvaal. When the restless Boer, impatient of British control, set out on his long "trek" from Cape Colony to the north, and chose the uplands of the Transvaal as pasturage for his stock, he knew little, and probably cared less, for the fabulous wealth which lay hidden beneath the soil upon which he built his home and turned loose his flocks. Yet so rich is the mineral wealth of this country that in 1892 or six years from the date of the discovery of the gold fields of the Witwatersrand, the output of gold from this district alone amounted to over $20,000,000.

It was estimated by expert mining engineers that in a few years from that date the annual output would exceed $50,000,000, and that this amount would show no diminution for many years to come. In addition to the gold deposits there are rich deposits of copper, iron and coal. Lead, cobalt, sulphur and saltpeter are found in lesser quantities.

The chief gold mines lie in the region of Lydenburg, in the Drakenberg range, and in the Johannesburg and Lower Kaap district. Diamonds are found in the Bloemhoff district on the Vaal River. There is a wide distribution of iron ore, and coal deposits exist in the southeastern districts and in Middleburg and Lydenburg to the north. In some places "seams seven or eight feet thick lie so near the surface that they are quarried and the coal carried away by the natives."

The Transvaal consists mainly of undulating grass land, the herbaceous flora predominating over forest growth. The forests are confined to the canyons of the mountains and to the river bottoms. Agriculture is in a backward state; the Boers preferring to breed stock rather than raise cereals, and, indeed, the Boer farm is more nearly allied to the cattle ranch of the Western than to the produce farm of the Middle or Eastern States in this country. The soil and climate are favorable to an advanced and varied agriculture; a fine grade of wheat has been raised, and it is said that most of the European fruits and vegetables can be grown in abundance and of a fine quality. The warmer northern districts are suitable to the raising of coffee, cotton and sugar.

History.—The Transvaal was first peopled by whites in any considerable numbers between the years 1833 and 1837, when the Boers made their "Great Trek" from Cape Colony to the north. They crossed the River Vaal, defeated and drove the Zulu chief across the Limpopo, where he founded the Matebele State, and established themselves in the land lying between the two rivers. During the next thirty years the Boers passed through a stormy experience, in which they were perpetually at war with the neighboring fierce and warlike tribes, and were, moreover, disturbed by internal dissensions. In 1853, Pretorius was elected first president of the Dutch African Republic. One great cause of internal dissensions appears to have been the passage in 1858 of what was known as the Fundamental Law, which declared that the "people would admit of no equality of persons of color with the white inhabitants either in state or church." In 1875 the Fundamental Law led to a declaration of war against Sikokuni, chief of the Bapedi, in the course of which the Boers met with repeated reverses which left the state "practically bankrupt, and exposed to danger of invasion by the Bapedis and Zulus." In the following year England intervened and annexed the Transvaal, appointing a British administrator. The revolt of the Boers in 1880 was followed by the treaty of 1881, which granted the restoration of the republic, subject to the suzerainty of the Queen. The election of Paul Kruger as president in 1883 was followed by the convention of London in 1884, in which the state was recognized as the South African Republic, and the British suzerainty was largely modified, the Queen merely retaining control of the foreign relations.

THE RIGHT HON. JOSEPH CHAMBERLAIN, COLONIAL SECRETARY.

The Coming of the Uitlander.—The antagonism between the British and the Boers dates from the last century, when the Dutch East Africa Company ceded the city of Cape Town to Great Britain. From that date onward the Boer has steadily resisted the advance of the Englishman with a stubbornness which has been begotten largely of a strong racial dissimilarity. The conservative Boer, clinging to the customs and traditions of his forefathers, has always looked with distrust upon the restless enterprise of the British colonist; and his proud spirit of independence has chafed under the control of British rule. He has ever been on the move; driving his stock to the northward, and settling, at first in Natal, and later, as the tide of immigration overtook him, in the land of Transvaal. Of late years, he has seen the rising flood of immigration completely encircling the republic. In 1885 the colony of British Bechuanaland was established on the western frontiers of the Transvaal; and four years later the British South Africa Company received a royal charter, which gave it control of the regions lying beyond the northern boundaries of the Boer state, and reaching as far north as the Zambesi River.

Simultaneously with this rapid extension of the power of his historic foe in the conterminous lands came the discovery of the rich auriferous deposits of the Rand, accompanied with a vast influx of people of various nationalities, of whom the majority were British. The immigration has been so rapid that today it is estimated that the Uitlanders, or Outlanders—as they are called by the Boers—outnumber the latter by four to one; there being a total of 60,000 Uitlanders to 15,000 Boer adult males.

Once again in the march of events the descendants of the Dutch settlers found themselves surrounded by the advancing tide of British influence; but with this difference, that they, the Boers, were no longer the governed, but the governing people. Two opposite courses were open to the much perplexed government: the one was to conciliate the friendship of the newcomers by encouraging them to enter into full citizenship, and extending to them the privileges of the franchise; the other was to jealously maintain the existing restrictions as to the franchise, according to which it is practically impossible for a foreigner, even if he enter into citizenship on the day of his arrival, to take any active share in the government of the country until the lapse of a dozen years. The Boers chose the latter course. Wisdom would have suggested a more liberal policy; but it can easily be understood that the government was keenly alive to the fact that to extend the franchise was to place themselves in the minority, and practically to hand over the control to their hereditary enemy. The London Graphic, to which journal, together with Black and White and the Illustrated London News, we are indebted for the accompanying illustrations, sums up the grievances of the Uitlanders as follows: "The native Kaffirs, who number about 250,000, have practically no voice in the government of the country. Neither have the Uitlanders. On the other hand, among the Boers, full rights of citizenship have been extended to boys of sixteen years of age. Of the members of the government a large number are not Boers, but imported Hollanders. The Boer lives upon his property, and is scarcely interfered with by the administration. He practically pays no taxes. The Outlander is taxed heavily, although he has no voice in the spending of the money levied. He demands the same representative power in the government as is accorded to the Dutch population in a British colony."

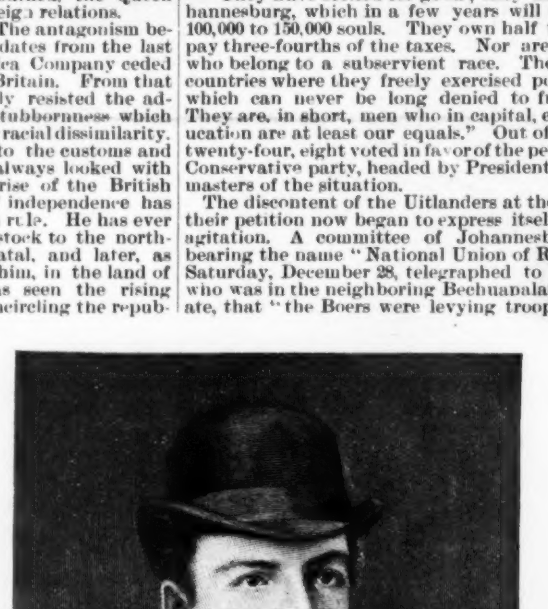
From this it would appear that these people are struggling against the same form of injustice—taxation without representation—that drove the American colonies to revolt in 1777.

There are some members of the Volksraad, or Boer Parliament, however, who are disposed to take a liberal view of the question. At the time when the recent monster petition for reforms, which carried 40,000 signatures, was presented, Mr. Jeppe, the Boer member for Johannesburg, described the Outlanders as follows:

"They have settled for good; they have built Johannesburg, which in a few years will contain from 100,000 to 150,000 souls. They own half the soil, they pay three-fourths of the taxes. Nor are they persons who belong to a subservient race. They come from countries where they freely exercised political rights, which can never be long denied to free-born men. They are, in short, men who in capital, energy and education are at least our equals." Out of a chamber of twenty-four, eight voted in favor of the petitioners. The Conservative party, headed by President Kruger, were masters of the situation.

The discontent of the Uitlanders at the rejection of their petition now began to express itself in organized agitation. A committee of Johannesburg citizens, bearing the name "National Union of Reformers," on Saturday, December 28, telegraphed to Dr. Jameson, who was in the neighboring Bechuanaland Protectorate, that "the Boers were levying troops and threatening to shoot down all who opposed them." Another telegram was sent to Governor Sir Hercules Robinson at Cape Town, which, owing to the fact that the wires had been cut, did not reach him for several days. Judging from the many conflicting accounts which have come to hand, it would certainly appear that the Johannesburg citizens were the first to commence to threaten hostilities. It is but just to the Boers to state that, however much they may have been in the wrong

THE HON. CECIL RHODES.



DR. JAMESON.

in their stubborn refusal to grant the rights of citizenship to the Uitlanders, they were not the first to begin the hostile preparations which eventually led to bloodshed.

Immediately on the receipt of the belated telegram, Sir Hercules Robinson dispatched a messenger in all haste to intercept Dr. Jameson and order his return. Dr. Jameson, however, was already over the border, which he crossed on December 29 with a force of mounted police, variously estimated at between 500 and 800 men, most of whom had seen active service in the Bechuanaland border police.

The first intimation which President Kruger received of this raiding body of troopers came from the local commandant on the western frontier. The "burgher" army—there is no standing army in the republic—was hastily collected, and General Joubert, the hero of Majuba, placed in command.

Dr. Jameson's force, after covering one hundred and sixty miles in the two days, found the Boer army, 2,000 strong, encamped in a strong position behind the crest of a hill. The battle of Krugersdorp was fought on new year's day. The Boer army was so arranged that it formed "an angle of two lines, with its apex at the top of the hill, into which angle the enemy must needs enter" in the effort to force the position. The Boers fought under cover, and repulsed the three attacks of the invaders; their splendid marksmanship telling with deadly effect upon the enemy. Krugersdorp is twenty-four miles from Johannesburg; and during the night Jameson made a detour of thirty miles in the hope of relieving the supposedly beleaguered city. The Boers had anticipated the maneuver, and again confronted the raiders in a strong position.

After several hours of fighting, and when their ammunition was expended, Dr. Jameson surrendered. Of the British force, eighty were reported killed, thirty-seven wounded and five hundred and fifty were made prisoners and lodged in Pretoria state jail. Jameson was tried in the High Court of the South African Republic and sentenced to be shot. Subsequently, as the result of a conference held at Pretoria with Sir Hercules Robinson, President Kruger handed over Dr. Jameson and all the other prisoners to be tried by the British government. Sir Hercules Robinson, at the same time, ordered the Johannesburg citizens to lay down their arms unconditionally. On January 8 the Queen sent a message of thanks to the Boer President, adding: "This act will redound to the credit of your honor, and will conduce to the peace of South Africa and to that harmonious co-operation of the British and Dutch races which is necessary for its future development and prosperity." The discovery of a chest of arms and cartridges consigned to one of the Reform Union leaders and the evident reluctance with which the citizens of Johannesburg obeyed the order to disarm, led to the arrest of the principal members of the National Reform Committee. The arrested parties represent various nationalities; and among them are several Americans, including Mr. John Hays Hammond, the noted mining expert. In response to the request of Secretary Olney, the British government has guaranteed to these American residents of Johannesburg the same protection as will be afforded to their own subjects.

When the tidings of these startling events first reached the outside world, they produced a profound sensation. The German Emperor sent a congratulatory message to President Kruger; and the world at large was severe in its criticisms of the British government, who, it was claimed, must certainly have been aware of, and therefore must have tacitly approved, the hostile demonstrations at Johannesburg and the unwarrantable invasion of a friendly state by Dr. Jameson and his band. Later evidence, however, makes it clear that, however much they may have sympathized with the political aspirations of the Uitlanders, the British government were in no way responsible for the Jameson "raid," and that they did everything in their power to prevent it.

The Future of the Transvaal.—Arguing from analogy, it is safe to say that in this, as in every other land in which the English-speaking race has multiplied and firmly established itself, the right of universal suffrage will be finally established. This will be brought about, not by such bungling and altogether unwarrantable methods as have characterized the late struggle, but by a steady continuance in methods of peaceful and lawful agitation. At the present rate of progress the Uitlanders must, within the near future, so greatly outnumber the Boers as to render their exclusion from an equitable share in the government an injustice before which even the bitter opposition of the conservative element in the Volksraad must give way.

It is evident from the words of Mr. Jeppe, in the Volksraad, which we have quoted above, that there is a section of the Boer people who realize that their best interests lie in the direction of a more generous and broad-minded policy in dealing with the newcomers; and it is to the growth of this party within the Parliament, aided by peaceful agitation without, that the people who, by their courage and enterprise, have made the Transvaal the richest country of its size upon the earth, must look for relief from their present exasperating and humiliating political condition. The question of the future of this aggregate of colonies, protectorates, and republics in Southern Africa is extremely interesting, and affords much food for speculation.

If the dreams of the late premier of Cape Colony, Cecil Rhodes, be fulfilled, the whole country will be included in a South African confederation. Such a confederation was proposed in 1886, and received the support of the Orange Free State, Cape Colony, and many of the Transvaal Boers, but it was opposed by President Kruger, and the scheme fell through. The events of the past few months have rendered the possibility of confederation—at least as far as the Transvaal is concerned—more remote than ever.

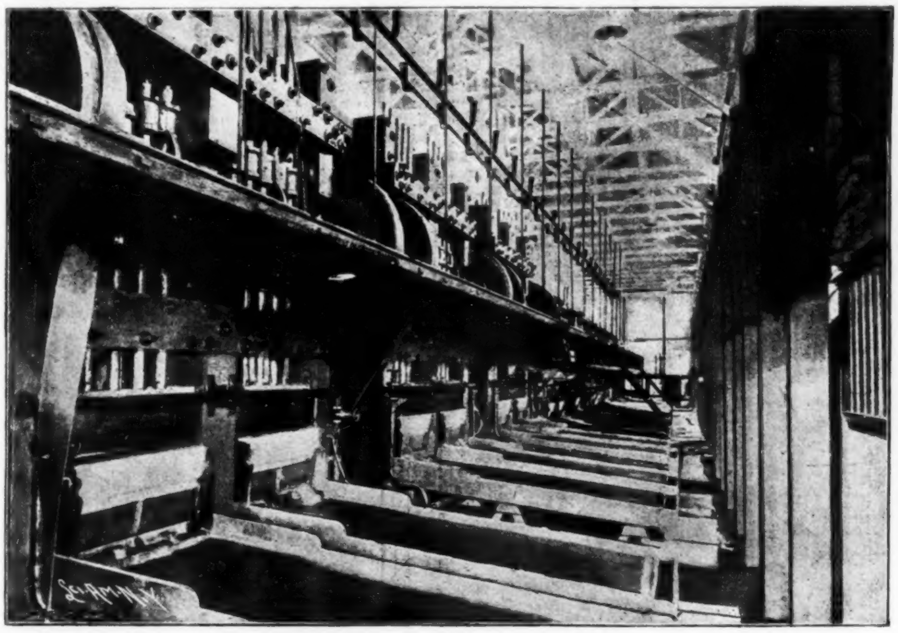
As an alternative to imperial federation, it is possible that we may ultimately see a United States of South Africa, in constitution and policy a counterpart of our own republic.

This sudden crisis in South African affairs has brought prominently into notice some men of more than common notoriety and of exceptional ability. We reproduce among other illustrations from the English journals, Illustrated London News, Graphic and Black and White, portraits of some of the most notable of these.

The Right Hon. Joseph Chamberlain, Colonial Secretary, has handled this badly tangled affair with a good judgment and moderation that have won for him the good word of his most bitter political opponents.

Cecil Rhodes, who came to South Africa a sickly youth of seventeen, in search of health, is to-day, though but forty-two years of age, perhaps the most striking personality in the British empire; a man "whose sphere of influence sweeps from Cape Town to Taganyika and from the Atlantic to the Indian Ocean."

Dr. Jameson, who as administrator of Matebeleland established a brilliant reputation for wisdom, moderation, and executive ability, turning its savage warriors into peaceful tillers of the soil, only to blast that reputation by perpetrating one of the most ill-advised and unwarrantable "raids" that were ever projected upon a neighboring and friendly state.



GOLD CRUSHING MACHINERY, TRANSVAAL.

TRANSVAAL STAGE COACH WITH BOER DRIVER.

TORGHATTEN, NORWAY.

UPON the coast of Norway, 132 miles to the north of Trondhjem, and in 65·5° of latitude, is situated the strange islet of Torghatten, well known to tourists who make excursions to North Cape. Its form, which is that of a gendarme's chapeau (the "hat of Torgen"), and especially the extraordinary natural tunnel pierced (by the arrow of a giant, says the legend) through its gneissic mass, make it one of the objects between Bergen and Hammerfest to which the attention of travelers is directed.

As much visited as it is every year, the Torghatten tunnel does not as yet appear to have sufficiently attracted the attention of scientists.

It was briefly described by Mr. A. Vibe in 1860 in the following words:

"L. De Buch attributed to the entire islet a height of 2,000 feet, while in reality it is but 1,000. . . . The altitude of the eastern (read northeastern) aperture is 380 feet, while the western (read southwestern) is a little lower, so that the floor of the tunnel deviates slightly from the horizontal. The height of the vault at the entrance is 120 feet, and that of the west is 220. In the center the height is but 90 feet. . . . The total length is nearly 900 feet, while the width varies from 100 to 150. . . . The most curious thing is that while the two entrances are encumbered with large blocks of fallen stone, there are but few blocks in the center, where, on the contrary, is found a fine sand so flat that a carriage might be driven over it."

Vibe, in going into ecstacies, as is proper, over the grand singularity of this tunnel, adds that he spent a whole day there in order to measure everything.

He must either have been strangely mistaken in his measurements, which is improbable, or else the state of the place has greatly changed since thirty years, for the following are the figures that, according to H. Mohn, are given in the Geographical Dictionary of Vivien de Saint Martin and in the Baedeker Guide for Sweden and Norway for 1882 (English edition):

	Feet.
Height of the islet	821
" " entrance (NE.)	407
" " vault (NE.)	65
" " " (center)	204
" " " (SW.)	246
Total length of tunnel	535
Width of tunnel	36 to 56

And Baedeker adds that the rubbish extends far into the interior.

On June 28, 1894, I myself made the following measurements, which, for altitudes, cannot be more than 15 feet out of the way, and which for the dimensions, taken by pacing, have an approximation of about 10 per cent. more or less:

Altitude of the entrance (NE.)	460 to 475 ft.
" " center of tunnel	375 to 395 "
" " entrance (SW.)	410 to 425 "
Width of center about	33 "
" at entrance (SW.)	78 "
Length about	490 to 525 "

It will be at once seen that these figures are much nearer those of Mohn than those of Vibe. And two well established facts especially are evolved from a comparison of the three series: (1) On the one hand, the horizontality of the tunnel reported by Vibe (and represented upon the inaccurate chromo lithograph

that accompanies his memoir) no longer exists, since I have found the center to be lower by 75 feet than the northeastern entrance and lower by 30 feet than the southwest one; and, on the other hand, the elevation of 65 feet (Mohn) for the northeastern entrance is, at the present time, much more exact than that of 120 feet (Vibe). The same is the case for that of the center, which is certainly nearer 204 than 90 feet; and if we add that the center of the tunnel also is absolutely encumbered with large blocks, and that a carriage might seek there in vain the sandy avenue of which Vibe speaks, it must necessarily be concluded therefrom that fallings of rock have taken place in the tunnel since 1860, at the entrance as well as in the center. The vault has been heightened, as has also the floor.

The length will have diminished also by nearly two-fifths. (2) The altitude of the northeastern sill of the tunnel equals in each respective series 390, 406 or 460-475 feet. Is such increase the simple consequence of insufficiently exact observations? Is it due to the constant accumulation of new rubbish at the entrance? Or does it not rather result from a heightening of the surface of the islet above the level of the sea? It is from this latter view point that it would be interesting to make accurate and continuous measurements at Torghatten. It is well known what debates have arisen between geologists (chiefly apropos of the fjords) on the subject of the so-called "hinge motion" that the Scandinavian peninsula executes around its transverse axis, sinking at the south (Scania) and rising at the north (Bothnia).

Now, may we not consider Torghatten (and perhaps some Norwegian geologist has already put forth the idea) as a registering evidence of this very slow movement? Not assuredly by reason of the divergences alone of altitude that I have just pointed out, and which, I repeat, can, for want of sufficient precision, furnish only a slight presumption and in no-

FIG. 1.—THE TUNNEL OF TORGHATTEN.

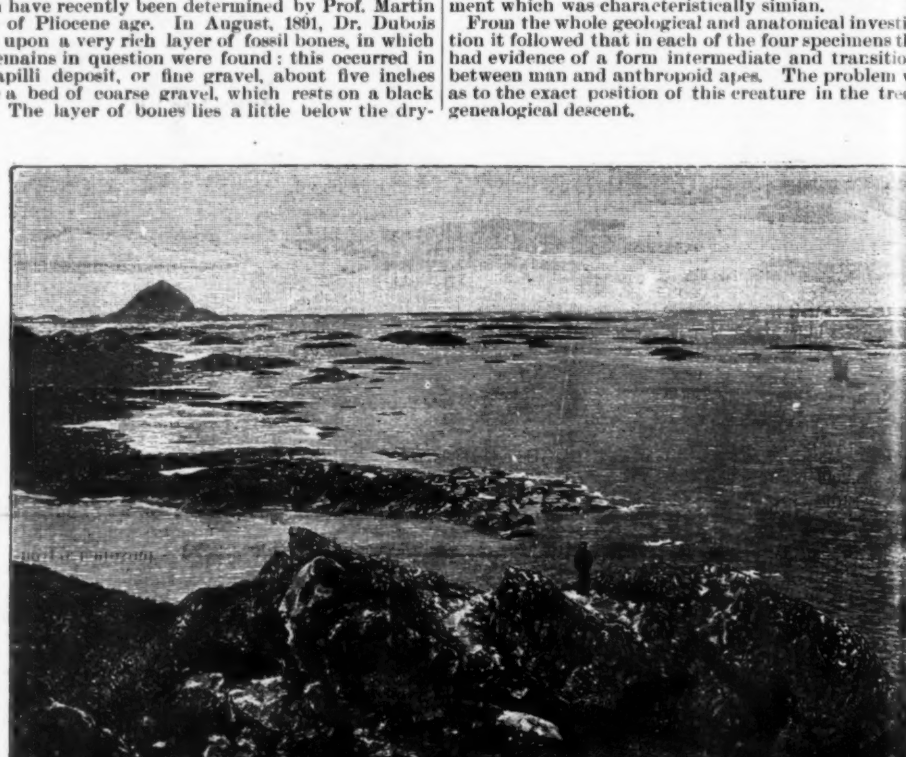


FIG. 2.—THE ISLET OF TORGHATTEN (IN THE BACKGROUND TO THE LEFT) SEEN AT A DISTANCE.

wise a certain basis, but on account of the very existence of the Torghatten tunnel.

Not being in calcareous rock, it does not owe its origin to the work of corrosion and erosion of the waters of infiltration charged with carbonic acid. Moreover, the superincumbent surface of the islet would have been, even in Jurassic formation, of too little extent to permit it.

It is clear that marine erosion has excavated this gigantic window. When we examine the vaults and the walls of the interior, it is easily explained to us that the waves of the tempests have been able to effect this piercing, for the rock is quite friable, and especially is divided throughout its entire height by two systems of vertical fissures or diaclases at right angles with each other, one transverse and the other longitudinal with the axis of the tunnel. The mass was therefore naturally, and in advance, divided into irregular parallelopipeds, which the impact of the waves has gradually dissociated and that inclemencies of the weather may yet, from time to time, detach from the vault. Much harder rocks, such as the porphyry of Esterel and the basalt of the Giant's Causeway in Ireland, have thus been perforated, owing to pre-existing fissures; and in this last locality there are two coast grottoes that are longer than and almost as high as the Torghatten tunnel. One of them even is similarly pierced through and through; but the level of the sea has remained the same as that of those grottoes, while at Torghatten the altitude of the tunnel is now from 390 to 475 feet.

Consequently, it seems difficult to deny that this islet, since the epoch of the piercing of the tunnel, has been elevated more and more above the waves that perforated it. The finding out as to whether this uplifting is continuing, with the endeavor to measure the extent of it, is therefore connected with one of the most important and most discussed questions of geology, that of the movements of the terrestrial crust. Having thus pointed out what may be the scientific value of Torghatten, let us recall, further, that it is a site of rare and original grandeur, too well placed upon a now well beaten road to render a longer description necessary. The views in the accompanying figures give but an imperfect idea of this majestic episode of the charming voyage to North Cape.—E. A. Martel, in La Nature.

DR. DUBOIS' "MISSING LINK."*

THE opening scientific meeting of the session of the Royal Dublin Society, on November 20, was of especial interest, owing to the presence of Dr. Eugene Dubois, who exhibited the famous remains which he discovered in Java. The chair was taken by Prof. W. J. Sollas, F.R.S. Dr. Dubois read a paper "On Pithecanthropus erectus: a transitional form between Man and the Apes," which will very shortly be published by the society, and which was illustrated by a number of lantern slides made in Dublin for this lecture. He said that when he was invited by Prof. Cunningham to read a paper before the Royal Dublin Society, he did not for a moment hesitate to comply, as he was anxious to get as much criticism as possible. By order of the Dutch Indian government he conducted, from 1890 to 1895, explorations of a fossil vertebrate fauna, of which some remains had been discovered many years ago by Junghuhn and others. These vertebrate remains, which were found abundantly at Trinil on the southern slope of the low Kendeng Hills, were obtained from beds of cemented volcanic tuff, consisting of clay, sand and consolidated lapilli, which were rearranged by fluviatile action. The whole formation attains a maximum thickness of over 250 meters. In these strata the Bengawan River has cut its channel 12 to 15 meters in depth. These beds lie unconformably upon beds of marine marl, sand and limestone, which have recently been determined by Prof. Martin to be of Pliocene age. In August, 1891, Dr. Dubois came upon a very rich layer of fossil bones, in which the remains in question were found: this occurred in the lapilli deposit, or fine gravel, about five inches above a bed of coarse gravel, which rests on a black clay. The layer of bones lies a little below the dry-season level of the river. The river bank was excavated with such care that the position of each specimen was accurately known. In September a wisdom tooth was discovered, and a month later the skull cap was found about one meter distant, and at precisely the same level. The work was interrupted by the rainy season, but was renewed in May, 1892; the left femur was found in August, at a distance of about 15 meters from the calvaria, and in October a second molar, at a distance of 3 meters from where the skull cap was found, and in a direction toward the place where the femur had been dug out. Among the associated animals may be mentioned large numbers of Stegodon, specimens of hippopotamus (Hexaprotodon), hyena, several species of deer, Bubulus, a gigantic pangolin three times as large as the existing Javan form, etc. The four remains were all in the same state of fossilization as the animal remains, the weight of the femur being nearly three times that of a recent femur. Doubt had been expressed whether the four remains belonged to the same individual; Dr. Dubois himself had no doubt on this point, as he had often found bones from the selfsame skeleton, and even fragments of a single bone, at similar distances apart; never had he found a complete skeleton. He had good reasons for believing that the animals perished in volcanic catastrophes, and their corpses were brought down a large Pliocene river, so that before the bones were finally deposited and buried they must have been separated by the rotting of the flesh; and there are evidences of crocodiles having preyed upon the carcasses.

The femur is so human-like that nearly all anatomists did not hesitate to declare it to be human; but up to the present no human remains had been found in the Lower Pleistocene, the oldest only reach down to about the middle of that period. Nobody had the slightest doubt that the bone must have belonged to a form with an erect posture. Only Virchow repeatedly maintained, even after seeing it, that it belonged to an ape, probably Hylobates, because it has, in his opinion, a straight shaft, such as never occurs in man; but the audience could easily see that the shaft of the fossil was by no means straight, and Dr. Dubois demonstrated some features which he had never seen in human femora, but which he believed to be simian characters.

For normal human proportions the capacity of the cranium was too small for the femur; but microcephalic skulls of the class which may be regarded as atavistic can be even relatively smaller, while the height of the body is more than that of Pithecanthropus, as computed from the length of the femur. Such was the case of the microcephalic idiot, Joe, described by Prof. Cunningham. The length of the Java cranium is 185 mm., its breadth 130 mm. The same dimensions in an average female chimpanzee's skull are 132 and 91, and those of a Hylobates 95 and 69. The internal capacity he estimated at 1,000 cubic centimeters. The largest skulls of the anthropoid apes average about 500 c. c. Normal human skulls are known of an equal or even less size than the Java cranium; but these small skulls are always associated with a small body. The chances are enormously against this being the skull of an idiot, and no microcephalic skull shows such a flattening of the parietal region. The orbital part of the skull is quite different from that of man, but the inclination of the nuchal plane is far more human than simian. From the genus Hylobates he could only find a difference in size and in the downward slope of the occiput; the resemblance between the two was most striking if the former was enlarged two diameters.

A divergence of opinion also prevailed as to whether the teeth were human or simian; they were larger than human teeth, and the cusps showed a relative development which was characteristically simian.

From the whole geological and anatomical investigation it followed that in each of the four specimens they had evidence of a form intermediate and transitional between man and anthropoid apes. The problem was as to the exact position of this creature in the tree of genealogical descent.

Dr. D. J. Cunningham, honorable secretary of the society, believed the specimens to be of supreme importance. Discussing Dr. Dubois' memoir at a previous meeting of the Royal Dublin Society, he had expressed the view that the cranium was distinctly human, and he still held that an unbiased study of the published description and figures could lead to no other conclusion. Now, however, when he was brought face to face with the actual specimen, he failed to see in it any decided and leading human feature, except its capacity of 1,000 c. c. He agreed with Dr. Dubois in considering that it most resembled the cranium of Hylobates, although he was of opinion that Dr. Dubois slightly exaggerated the relative height and quality of the cranial arch in Hylobates. In this respect he considered that, if fairly tested, the fossil cranium would be found to be superior to any known ape. Certainly the cranial arch was vastly superior to that of a gorilla, chimpanzee, or orang, and he believed also that it was relatively fuller and loftier than the most highly arched Hylobates cranium. Dr. Dubois placed some stress upon the inclination of the nuchal area of the occipital bone, and thought that in this there was a human characteristic; but he (Dr. Cunningham) thought that this region of the cranium was extremely ape-like, and, further, he did not altogether consider that the means which Dr. Dubois had taken to determine the degree of this inclination were calculated to yield absolutely trustworthy results.

With regard to the femur, he had nothing to add to what he had previously said on this subject. It was a human bone, and while he fully appreciated the distinctive points alluded to by Dr. Dubois, he thought that Dr. Dubois had not made sufficient allowance for the variation to which this bone was liable. It was, to say the least of it, strange that a thigh bone of such undoubted antiquity should exhibit none of those characteristics which we were in the habit of associating with prehistoric femora, as well as with the femora of rude and savage races of the present day. It showed no signs which would indicate that the individual to whom it belonged was in the habit of assuming the squatting attitude.

In so far as the two molar teeth were concerned, he

* From Nature.

still held that the features which they exhibited were more human than simian, although it could not be denied that they also exhibited some very decided ape-like characters.

The question as to the place which should be assigned to the fossil form on the genealogical tree was a most interesting one. On this point he differed entirely from Dr. Dubois. Dr. Dubois placed Pithecanthropus below the point of devarication of the anthropoid apes from the human line. Dr. Cunningham, on the other hand, placed it on the human line, a short distance above the point at which the anthropoid branch is given off. In urging this view, he stated that he could not believe that an ape form with a cranial capacity of 1,000 could be the progenitor of the man-like apes, the largest of which had a capacity of only 500. Such a supposition would necessarily involve the assumption that the anthropoid apes were a degenerated branch from the common stem.

Prof. Haddon said: Ever since the evolution hypothesis had shed such an illumination upon nature, biologists had believed in the previous existence of forms intermediate between man and the lower animals; and it was with a fearful joy that they heard of Dr. Dubois' discovery, and then they subjected the remains to a searching criticism, with the result that all agreed that the individual to whom the cranium belonged was transitional in character between the apes and man—some thinking him more ape-like, and others more human; balancing the one set of opinions against the other, they could only come to the opinion that it was an intercalated type. While agreeing with Dr. Dubois in all his statements of fact, he concurred with Prof. Cunningham in thinking that the size of the cranium was an insuperable difficulty in the way of placing the individual to which it belonged below the point in the genealogical tree where the anthropoids branched off. Palæontological evidence points to the fact that in the evolution of any series of mammals the brain tends to increase in size; at all events, there is no known case of a brain decreasing to less than half its original dimensions. Nor did it appear to him to meet the case to suppose that by doubling the body of a gibbon the brain would be equally doubled in size; there was no such proportion between body growth and brain growth.

Dr. Pearsall, a leading dental surgeon in Dublin, made some remarks about the teeth, and said that the human characters of the teeth were very striking.

Prof. Sollas agreed with the preceding speakers as to the invaluable evidence afforded by these fossil remains. They indicated an organism which was either a pithecoid man or a remarkably human ape; which of these alternatives might prove to be true was a matter of secondary importance, the fact remained that we had before us traces of the most simian ancestor of the human race yet known.

The materials for determining its geological age were abundant, but not yet fully worked out. Dr. Dubois, however, stated that the associated mammalian fauna stood in close relation to that of Nerbada beds and the Upper Siwaliks of India; and so far as it might be possible to correlate the Javan deposits with those of Europe, they would appear to be older than our river drifts, and possibly on the same horizon as the forest bed of Norfolk. In this case the intervals of time and the differences of structure which separate the Javan fossils from the race of Spy, and this from existing man, would be, so to speak, proportional.

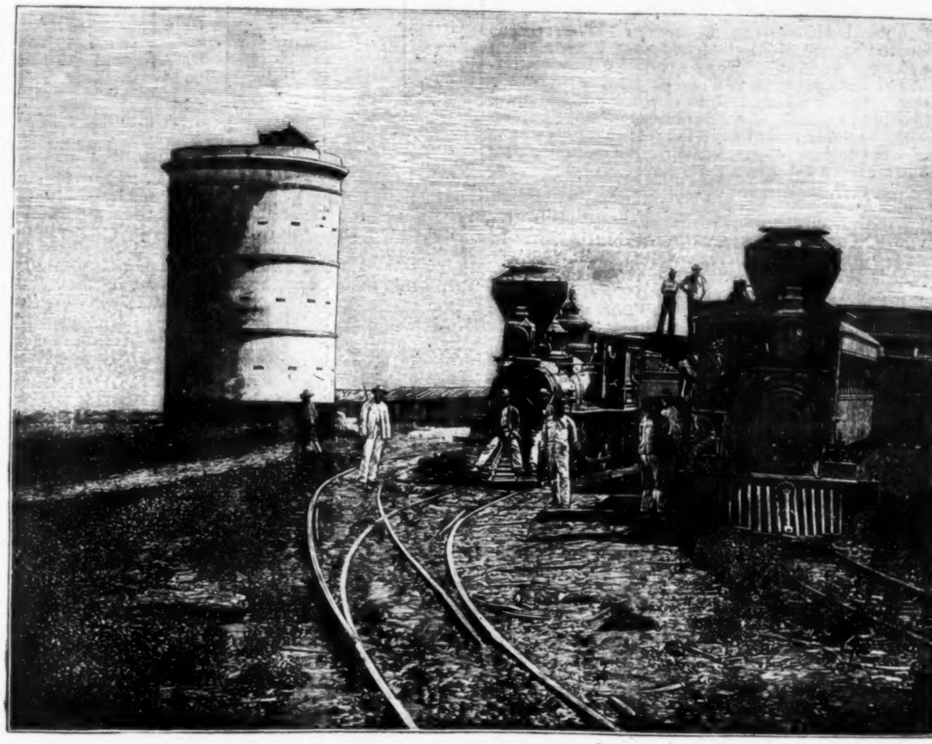
In the Miocene times we first meet with a few modern genera struggling to the front from a crowd of competitors; and in the Pliocene a few modern species emerge, and thus in the case of the human race, we might expect to find the existing species Homo sapiens replaced by some earlier representative, say Homo innocens in the Pliocene, and the genus Homo by allied though different genera of the family Hominidæ in the Miocene. While, however, Hominidæ are not yet known from the Miocene, remains of anthropoid apes (Dryopithecus) are, and thus what palæontological evidence exists lends no favor to the view that the anthropoids are degenerate descendants from the human stem. Thus Prof. Sollas was less inclined to agree with Dr. Dubois than with Prof. Cunningham in estimating the human characters of the Javan fossils.

Dr. Dubois thanked the Society for the honor they had done him and for their kindness. He explained why he placed Pithecanthropus in a different position in the genealogical tree from that assigned to him by Prof. Cunningham. They knew very little about the laws of evolution, which in some cases proceeded slowly and in others quickly.

The proceedings then terminated.

CUBA—AN EXPLORING TRAIN ON THE ZAZA RAILROAD.

MUCH has been heard of ruined railroads, bridges and viaducts and derailed trains in Cuba. The first to use dynamite in towns for the purpose of interrupting railroad traffic were the chiefs Roloff and Serafin Sanchez, who disembarked, with a considerable amount of that substance, early in August, almost in sight of the Tunas de Zaza. In two or three days they destroyed three bridges and a viaduct on the road from said city to Sancti Spiritu (45 miles long), and then after these had been repaired, no train passed that was not molested in some way. For the sake of greater safety, each passenger train is preceded by an exploring engine and one or two cars which carry soldiers. The accompanying engraving shows one of these trains prepared to start from the station on a reconnoitering expedition.



AN EXPLORING TRAIN ON THE ZAZA RAILROAD.

THE WAR IN CUBA.

THE civil war now raging in the island of Cuba between the Spaniards and the Cubans has, within the past few weeks, appeared to be growing in extent. The insurgents have pushed their troops from the eastern end of the island as far as Havana, which at present is in a state of partial investment; this despite the utmost efforts of the government to check or defeat them. All the principal sea coast towns are still held by the Spaniards, who are rapidly surrounding the island with a cordon of small gun boats, and at the same time are pouring in regiments of fresh soldiers from Spain. The government labors under the idea that by guarding the coast and its cities all foreign supplies of the insurgents will be cut off, and this being done, the war will at once dwindle and cease. The insurgents laugh at this, as they depend more upon their captures of arms and munitions from the enemy than upon exterior aid. Now and then the outside world receives particulars direct from the insurgent quarters detailing their successes in this line. But most of the accounts of the war are from Spanish sources, and in almost every instance they claim great victories over the insurgents, although the latter are admitted to be greatly superior in numbers. According to these accounts it is common for an army of forty Spanish soldiers to put to flight a body of 350 rebels, many of whom are claimed to be killed, many wounded, horses captured, camp and supplies taken, etc. It appears to be certain the rebels manage to keep their enemy busy. The fighting is chiefly confined to guerrilla bands. To watch and guard against the operations of a small party of rebels requires a much larger party of Spanish soldiers. Wherever they go the Spaniards find it necessary to erect small forts and observatories where some of the members of a force may be protected from capture while others go in search of the enemies' scouts.

When the revolution of 1868 broke out, Mr. Carlos Manuel de Cespedes, the initiator of same, owned a sugar plantation called "La Demajagua," located five miles south of the town of Manzanillo, and situated near the sea shore. In that plantation took place a gathering of the Cuban revolutionists on the night of October 9, 1868, and next day they marched upon Yara, where the cry for liberty was given. Shortly afterward a Spanish gun boat bombarded the plantation, the buildings were burned and destroyed. "Seeking for this historical spot," says Mr. José Gomes Carrera, "I was surprised by the curious and natural phenomenon of the tree that had grown in the middle of the machinery, and I photographed it." The picture shows the tropical rapidity of tree growth in Cuba. The branches have woven themselves in among the machinery, and the natural rise of the tree in its growth has gradually lifted the great wheel, together

CUBA—SUGAR MACHINERY LIFTED BY TREES.

with the engine foundation. We are indebted to Mr. Carrera for the photograph from which our plate was prepared.

[Continued from SUPPLEMENT, No. 1048, page 16750.]

THE ARC LIGHT.*

By Professor SILVANUS P. THOMPSON, D.Sc., F.R.S.

LECTURE II.

OPTICS OF THE ARC.

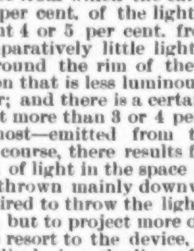
THE optical phenomena of the arc are nearly as complicated as are those electrical phenomena which occupied us a week ago. They vary with every different kind of carbon that one may employ, with every different value of current that one may use with a given carbon, and with every different kind of adjustment that one may have in the lamp that regulates the carbon. In a lecture such as this, one can only deal with a few salient facts in a few typical cases.

DISTRIBUTION OF LIGHT OF THE ARC.

The first and most important case to consider is that of the normal arc produced by the continuous current. There are two possible general cases of this also. The first case is that in which the current descends from the upper carbon to the lower, and is generally adopted for the lamps used for outdoor work. The second case, which is rather exceptional, and is only adopted in certain cases of indoor illumination, is that of the inverted arc, where the current ascends from the lower carbon to the upper. As the former is the more usual, we will deal with it. In this lantern we have now an arc formed; the particular regulator employed here being a Serrin lamp of the old fashioned sort. I use it rather than any more modern mechanism, simply because it is convenient as a table lamp. In front of the arc, which is formed here between these carbons, we have a lens in order to project the view of the arc upon the screen, and we can, if need be, introduce in front of the lens an erecting prism to rectify the position of the image on the screen. You now see upon the screen the image of the arc formed between the carbons. The positive carbon, with its luminous crater, is at the top; the negative, with its characteristic peak, is at the bottom; and in between them is a violet colored flame or arc, consisting of the column of carbon vapor through which the current descends. By a very small adjustment of the upper carbon, I arrange the position of the points so as to enable you to get a better view of the crater. Here is the first and most obvious optical fact, that the light comes from the white hot surface from which the carbon is evaporating. About 90 per cent. of the light comes from the crater and about 4 or 5 per cent. from the negative peak; while comparatively little light comes from any other part. Around the rim of the crater there is, however, a region that is less luminous, not so hot, and of a redder color; and there is a certain small percentage of light—not more than 3 or 4 per cent. of the total light, at most—emitted from the intermediate flame. Now, of course, there results from this a peculiar distribution of light in the space all around; the light is, in fact, thrown mainly downward.

When it is desired to throw the light not symmetrically downward, but to project more of it in a horizontal direction, we resort to the device, introduced first by Duboscq, of displacing the line of the carbons, so that the negative peak, instead of being exactly under the center of the upper carbon, is brought a little forward (as in Fig. 10). The crater then forms obliquely,

FIG. 10.



with the negative peak in front of it. This effect I will now produce by simply shifting the upper carbon backward. As I gradually displace the upper carbon to one side, the form of the crater will change: the positive carbon will burn away more on one side than the other. It takes a few minutes to change its shape, during which time the light will be unsteady; and when the new form has been assumed, we shall find that the light is thrown mainly on one side, as is desired for projector purposes, and for use in the optical lantern. We may have to let the arc burn untouched for something like half an hour, in order that the final shape of the surfaces may be properly assumed. As the maximum emission of the light is at right angles from the luminous surface, we shall now have obviously a different distribution in the illumination.

DISTRIBUTION CURVES.

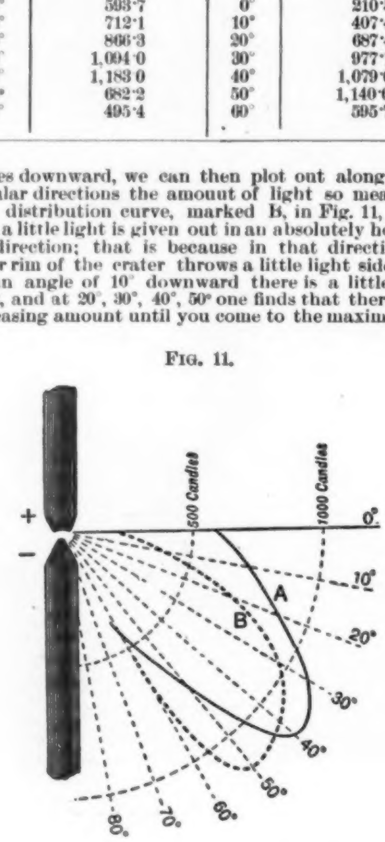
For a period of fifteen years or more back, it has been customary in the laboratory to measure and plot out the amount of light given by arcs in different directions, and to study the curves of distribution produced in that way. Two examples of these are shown in Fig. 11. Curve A relates to an arc produced at a constant voltage on a low pressure system of supply. Curve B to an arc produced with an unvarying current on a high pressure system of supply; other arcs being in series with the one measured. The mean current for both was about the same. The data of the measurements (which are taken from an American source) are given in the table.

If we select some photometric arrangement which will enable us to measure the amounts of light given out in different directions horizontally, and at different

(A) LOW PRESSURE.		(B) HIGH PRESSURE.	
Angle.	Candle power.	Angle.	Candle power.
0°	593·7	0°	210·5
10°	712·1	10°	407·4
20°	866·3	20°	687·4
30°	1,094·0	30°	977·1
40°	1,183·0	40°	1,079·0
50°	682·2	50°	1,140·0
60°	495·4	60°	595·7

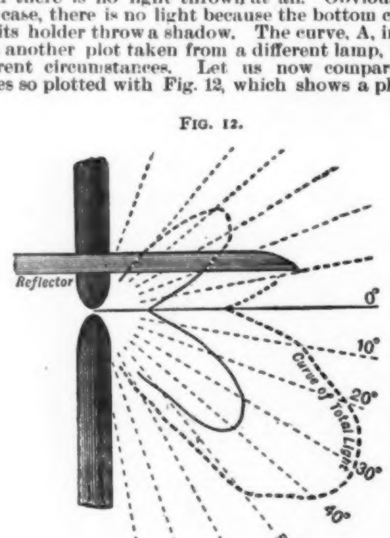
angles downward, we can then plot out along these angular directions the amount of light so measured. The distribution curve, marked B, in Fig. 11, shows that a little light is given out in an absolutely horizontal direction; that is because in that direction the lower rim of the crater throws a little light sideways. At an angle of 10° downward there is a little more light, and at 20°, 30°, 40°, 50° one finds that there is an increasing amount until you come to the maximum in

FIG. 11.



one particular direction, which, in this case, is about 50° from the horizontal. As you go further along you find that the light suddenly diminishes, not absolutely abruptly, but very rapidly, while absolutely straight down there is no light thrown at all. Obviously, in that case, there is no light because the bottom carbon and its holder throw a shadow. The curve, A, in Fig. 11, is another plot taken from a different lamp, under different circumstances. Let us now compare the curves so plotted with Fig. 12, which shows a plot re-

FIG. 12.



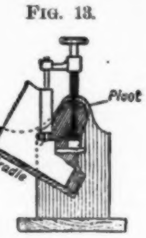
lating to an alternating current lamp. In such lamps the two tips do not materially differ in form from one another, provided the quality of carbon is alike and the pencils of equal thickness. Both tips take the form of a blunt peak. This form would be exactly alike were it not for the fact that the hot air ascending at the sides heats the upper carbon more, so that it becomes slightly more coned than the lower one. In this case the black curve represents the amount of light in various directions. Some is thrown downward at an angle, and almost an equal amount is thrown upward at an equal angle, with intermediate values in intermediate directions. But if a reflector is interposed to catch the light that is going upward and throw it also downward, one obtains the distribution plotted out in the dotted curve.

DEPENDENCE OF DISTRIBUTION ON SHAPE OF CRATER AND PEAK.

During the minutes which have elapsed our arc has been steadily burning, and the crater on the upper carbon has assumed the oblique position. The peak remains as a peak, and is visible against the crater surface, which it partially hides from our view. The main amount of light (see Fig. 10) is now given off in a not quite horizontal direction.

To make experiments on the amount of light given out in different directions, one requires either a photometer capable of being shifted round into all possible angular positions, or some apparatus for turning the arc into different inclinations with respect to the photometer. There is, however, an intermediate possibility, namely, some method of optically tilting the lamp, so that its light shall still come to the photometer, no matter what the inclination may be. To enable you to see upon the screen what the arc looks like when viewed at different inclinations, the following apparatus has been devised (Fig. 13).

FIG. 13.

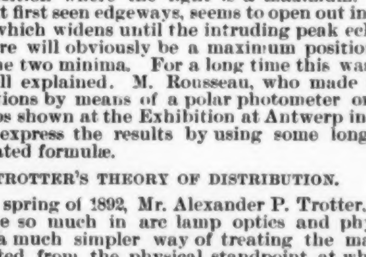


Here is a small projector lamp (made by the Planet Company) for the purpose of magic lantern work. This little lamp is fixed on a cradle-shaped stand, so that it can be rocked about on horizontal trunnions; the line of axis of these trunnions passing right through the arc. When the arc is burning steadily, while we project its image upon the screen by means of a lens placed in front, we can tilt it to any angle desired and set it either vertically or with any desired inclination toward the horizontal plane. So here we accomplish the same result as viewing the arc obliquely from positions below.

If I set the cradle so as to bring the rim of the crater into the horizontal plane, with the carbons vertical, I shall have the arc in the position of habitual use (Fig. 1, ante), and on the screen you see the sideway view. You see that very obvious peak, and above it the edge of the white hot crater. If I lengthen the arc a little, you will see the peak burn away to a blunter form, while the crater will become flatter. Having now seen the form sideways, I will tilt back the cradle, so that we may get another view of it. The duller spot which you see in the middle of the crater arises from the circumstance that we are employing a cored carbon, that is to say, a carbon with a hole down the middle, packed with carbon of a more or less soft quality and possibly not quite pure. As the cradle is tilted the negative peak comes in front of the crater and shows dark against its luminous surface. Turning it to a still steeper angle, so as to get in a horizontal direction the equivalent of the light which would otherwise be thrown obliquely downward, we find the negative peak almost eclipsing the crater and cutting off its light.

Fig. 14 shows four views at four different angles, 0°, 30°, 50° and 70°. In the two extreme positions, where

FIG. 14.



the crater is seen only edgeways and where it is eclipsed by the peak, there is very little light; but at some angle between these two there will obviously be a position where the light is a maximum. The crater, at first seen edgeways, seems to open out into an ellipse, which widens until the intruding peak eclipses it. There will obviously be a maximum position between the two minima. For a long time this was not very well explained. M. Rousseau, who made some observations by means of a polar photometer on the arc lamps shown at the Exhibition at Antwerp in 1885, tried to express the results by using some long and complicated formulæ.

TROTTER'S THEORY OF DISTRIBUTION.

In the spring of 1892, Mr. Alexander P. Trotter, who has done so much in arc lamp optics and physics, showed a much simpler way of treating the matter. He started from the physical standpoint at which I explained in my first lecture I arrived in 1889, viz., that because the arc is a phenomenon due to the volatilization of carbon, it will have a definite temperature, and, therefore, assuming that temperature to be definite and the carbon to be pure, the light emitted at the crater surface will have a definite whiteness. Starting from that point, he argued as follows: It does not matter for optical purposes whether the crater is actually flat or whether it is literally of a cup shape, since a luminous surface gives out only as much light in any direction as would be given out by a flat surface of equal intrinsic luminosity having exactly the same outline. This may seem a little strange, because it is contrary to one's experience of surfaces that are not self-illuminating. Take, for instance, an ordinary white saucer illuminated by the sky or by artificial light. If you set that saucer up in any one particular position and inquire how much light it throws to your eye as you move round it in different directions, you will find as matter of measurement that the amount of light given out in different directions does not depend simply on the visible size of that saucer, but owing to the circumstance that it receives its light at a particular angle and reflects it, the amount of light given out to your eye by any visible area of its surface depends upon the angle at which you see it. But where you are dealing with a self-luminous surface this is no longer true. For instance, take a piece of white paper as a sort of model: imagine it to be a white hot surface. Look at it through any definite aperture, for instance through this tube; you will see a round luminous disk (of a certain size, limited by the aperture). It will not make 1 per cent. difference whether the white surface behind it

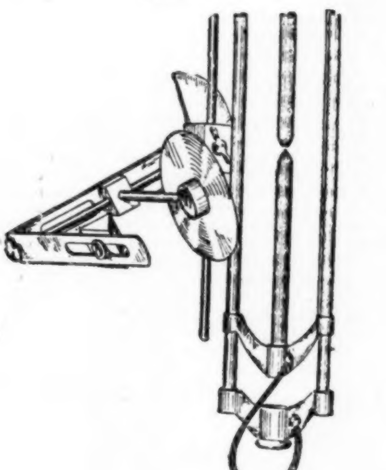
* Lectures delivered before the Society of Arts, London, 1895.—From the Journal of the Society.

is absolutely square across or whether it is turned or tilted obliquely. As long as there is enough white surface behind to extend completely across the visible aperture, the aperture will look equally bright. The angle of incidence to the sloping surface behind the aperture has nothing to do with the brightness. The self-luminous surface is equally bright whether it slopes or whether it stands squarely opposite to the eye. The crater surface may, therefore, for optical purposes, be considered to act as a small white hot horizontal disk.

The amount of light that it will emit in any given direction will depend simply, in the first place, on the intrinsic brightness, and, secondly, on the visible area which it presents when viewed in that direction. The more obliquely it is viewed the less is the visible area. The amount of light ought to be strictly proportional to the apparent area as viewed in the direction in question. Mr. Trotter's first point, then, is that the crater, no matter what the actual hollow may be, may be treated as a flat disk suspended somehow or other up in the air, and shining white hot.

Then what will be the geometrical distribution of light in all directions from this disk? That will be simply a matter of angle, or, rather, of the cosine of the angle. The disk will appear biggest, at any given distance away, if the eye is placed exactly opposite it. Because when the disk is square across the line of sight, it obviously will subtend the greatest apparent angle in space. It will appear of no size at all in directions at right angles to this, because the disk is edgeways, and the edge has no visible magnitude quantity. There will be no light in that direction; in other directions there will be some light. There will be a maximum in the direction of the normal to the surface; and the amount in any other direction will be simply proportional to the cosine of the angle which that direction makes with the normal. If you take the cosine of the angle as measured from the normal, or the sine of the angle as measured from the horizontal plane, and plot out the values in a polar diagram, as in Fig. 16, you will find the points all lie on a semicircle. In brief, cosines plotted as a polar curve give geometrically a circle that passes through the pole. Therefore, if this law were to be literally fulfilled, and if our crater were a horizontal disk up in the air—whether circular in outline or not is immaterial—the amount of light measured in different directions, provided there were nothing to interfere, would plot out simply on a semicircle, giving us the diameter of the semicircle as the greatest amount of light measured down underneath the disk.

FIG. 15.



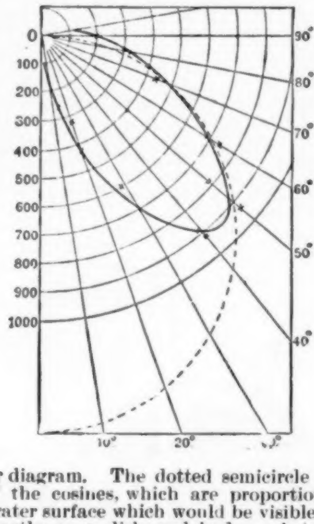
Unfortunately, the arc lamp consists of something more than a top carbon with a level crater at the end of it. There is that unavoidable negative peak which gives out very little light of its own, which is merely being roasted in the heat of the crater above it, and which casts a shadow. If you will measure the amount of the eclipse that goes on in different directions, you will get a measure of the amount of light cut off in those directions from the amount that would be strictly proportional to the cosine of the angle. No sooner had Mr. Trotter conceived this idea than he was good enough to come and talk it over with me at the Technical College. I put one of my senior students, Mr. C. F. Higgins, at his disposal to devise a little piece of apparatus to test this theory. Mr. Higgins constructed the apparatus used by Mr. Trotter in the investigations which followed. I have the apparatus here (Fig. 15) fixed on one of the Planet Company's lamps.

There is attached to the framework of the lamp the small apparatus by means of which the light given out from the arc in any direction can be examined. A lens is placed opposite the arc at a certain distance away, the light from that lens is received on a small mirror, having its front face metalized. The mirror being set at 45° sends out the light at right angles, to a distant screen, where the image is received. Then by merely tilting to any desired angle the frame which carries lens and mirror, one can examine, in any direction within wide limits, the visible appearance as presented in that direction.

Armed with this instrument one can make photometric measurements of the light sent out at different angles, without moving either lamp or photometer. But of more importance is the fact that by focusing the images on the screen, one can make pictures of the visible forms of the carbons. Putting a sheet of white paper against the screen, you project on it any particular view of the arc you like, and then with a drawing pencil outline the projection on the paper. Having in this way obtained a series of sketches of the arc as projected at various known angles (and all on the same scale) you may then go over each sketch with a planimeter and measure up the amount of luminous surface that is visible in different directions.

This elegant method of determining the illuminating effect at different angles is a feature of Mr. Trotter's investigation.* In his paper Mr. Trotter gives his results plotted out in the form of curves. In one curve he plotted the intensity of the light as measured in different directions. In another curve he plotted the amount of visible crater area, as measured in the different directions. So close is the agreement, that the curves are scarcely to be discriminated one from the other. Fig. 16 gives the curve of visible areas plotted as a polar diagram. The dotted semicircle gives the values of the cosines, which are proportional to the area of crater surface which would be visible if it behaved exactly as a disk, and had no obstruction in front. The light in any given direction is apparently proportioned to the amount of visible crater area exposed in that direction. This is a very important result, because it enables us to see exactly why the light is distributed as it is. Before Mr. Trotter's experiments there had, however, been some other observations made dealing with the relation between the amount of light and the amount of current.

FIG. 16.

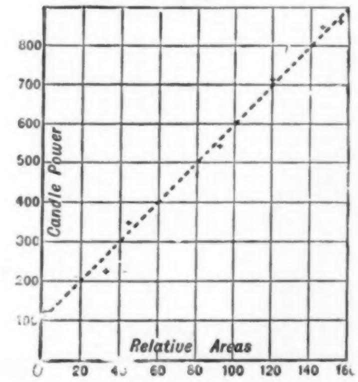


INTRINSIC LUMINOSITY OF THE CRATER.

Let us proceed to correlate Mr. Trotter's observations on the relation between the amount of light and the crater surface with those earlier observations on the relation between the crater surface and the current.

We will take first of all Mr. Trotter's results, in which we compare together the amount of light, as measured photometrically, and the amount of crater area, as determined by projecting the images on the screen, and measuring them with a planimeter. Fig. 17 gives in graphic form the result of Mr. Trotter's researches on the relation between the candle power of the arc and the visible area of the crater surface.

FIG. 17.

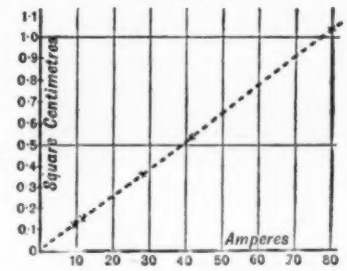


The candle power is plotted out vertically and the corresponding areas of crater surface are plotted out horizontally; they lie practically on a straight line. The main thing substantiated is that, taking a certain datum line horizontally across the diagram at about 100 candles, any amount of light above that datum line is exactly proportional to the amount of area of crater surface. Then what is the meaning of having this datum line above the actual zero of candle power? It means this, that all the light below that line drawn at about 100 candles was due to other parts than the crater. That is to say, the total amount of light given out by the negative peak, by the duller red-hot regions around the peak, and around the rim of the crater, and by the flame of the arc, amounted to about 100 candles. If we, then, discount this extra light which strays in from the other parts, we may say that the light given out is strictly proportional to the area of the crater surface.

The other result I wished to correlate with this was an observation of Mr. J. D. F. Andrews on the relation between the crater area and the current going through the lamp. This research dates from 1880, before we began to talk about amperes of current, and when we talked about webers. Andrews' researches were on the number of webers of current going through a searchlight and the amount of crater area as measured in the following way. After the lamp has been allowed to burn steadily for a given time, the current was stopped and the carbons taken out. The size of the crater was measured up, and from that the area of crater surface was calculated. The observations plotted together, as in Fig. 18, give a straight line which goes right down to zero. The current in these experiments was found to be rigidly proportional to the actual area of the crater. Consequently it follows, from Mr. Trotter's results, that the amount of light given out by a lamp (in any given direction) is also proportional to the current passing through that lamp.

If, then, the light emitted is simply proportional to the effective crater area, it ought to be possible to set down in definite terms the specific luminosity of the arc crater as so many units of light per unit of area.

FIG. 18.



Many years ago, Mr. Hiram Maxim had arrived, I know not by what process, at a similar conclusion. He gave the rough-and-ready rule that you can calculate the total candle power of a lamp by measuring the diameter of the crater in hundredths of an inch, squaring the number, and then multiplying by 10. This is equivalent to 127.000 candles per square inch, or approximately 200 candles per square millimeter—a a figure which is high compared with those of other observers. Abney's values range from 39 to 116; Andrews' from 64 to 170; Trotter's from 80 to 170; while Blondel's value is 160. The number of amperes per square millimeter of crater surface is about 0·78; so that the number of candles per ampere should be over 200. Palaz gives 204 to 240 in the direction of maximum brightness.

It will not, however, do to jump to the conclusion that because the crater area, and, therefore, the total quantity of light emitted, is proportional to current, that doubling the current in any given arc lamp will exactly double the light that that lamp gives out. For, if the current used at first is appropriate for the carbons of the size employed, a double current will be much too great to produce a proper crater, and the pencils will overheat. Moreover, the distance between the tips and the form of the tips will differ, and the distribution of the light will be different, preventing a fair comparison. Palaz gives the empirical rule that for a given lamp and carbons working between 40 and 50 volts, the number of candles ("bougies decimales"), if measured in the direction of maximum brightness, is equal to $200\,C + 4\,C^2$, where C is the current expressed in amperes. According to this, a 10 ampere current would give 2,400 candles in the maximum direction, while one ampere would only give 204. (The mean hemispherical brightness is only about two-thirds of the maximum.)

[Note added, October, 1895.—Shortly after the delivery of this lecture, Mrs. Ayrton published in the Electrician the results of her measurements of the crater, from which it appears that the current is not exactly proportional to the area of the crater, nor yet to its diameter, but to some power of the diameter between 1 and 2. On examining the curves on which her formula is based, it seems evident that further experiments are needed before the approximate law that the area of the crater is proportional to the current can be condemned.—S. P. T.]

ENERGY SPENT IN THE ARC.

Before passing away from the relations established above, let us pause for a moment to consider the energy question. You may sometimes find it said, and it is perfectly true when you are dealing with a fixed resistance, that the energy spent by a current is proportional to the square of the current. That is, in fact, Joule's well-known law. If you double the current through a given resistance, the amount of energy you have to spend is fourfold; and if you were heating carbon, you would perhaps argue that the light would be fourfold. But here we are confronted with the fact that, whatever the law might be supposed to be, when the current is doubled the light is doubled, not quadrupled. The light does not go by the square of the current. There is no paradox or puzzle in the circumstance, if one has once realized that important point developed in the former lecture, that the resistance of the arc is by no means a constant; that if you treat the arc as possessing a resistance, simply then you must say the apparent resistance of the arc for a given length varies inversely as the current. When you double your current, the resistance of your arc becomes halved. If, however, you treat the problem in the other way (which seems more rational), as involving the consideration of a back electromotive force, seeing that the back electromotive force is a nearly constant quantity, you must calculate the work done in another way, namely, as work done in driving a current against the opposing electromotive force. There would, in fact, be no work done at the crater surface if there was not located there something in the nature of back electromotive force. To put the thing in simple mathematical form: If V represents the number of volts against which you are driving the current (i. e., the true back electromotive force of the arc), and C stands for the number of amperes of current, then the work done per second is the product of those two. If we were dealing with a constant resistance, V itself would be proportional to the current; hence the product of the current into V brings the current twice over into the expression for the work done. Where, however, we are not dealing with a constant resistance, there being a fixed voltage to do work against, we must use the law in this shape just given; the work done in driving a current against a back electromotive force is the product of the two. If the voltage against which you are working is a constant, it follows that the power expended is proportional simply to the current, not to its square, a conclusion

* Journal Inst. Elec. Engs., 1892, xxi, 360.

which is justified by the fact that the amount of light given out is proportional also to the current, other things being equal.

(To be continued.)

WATER MOTORS AND THEIR POWER.

By G. D. Hiscox, M.E.

The increasing want of small power and its supply through the medium of water pressure made available by the great number of city and town water works, artesian flowing wells and the innumerable streams and brooks in the hilly parts of all countries—where the loss by the inefficiency of the common water wheel bars its use, or makes it a negative quantity—has been met by inventive genius, stimulated by the requirement in the production of the very efficient forms of the small water motors, as now found on the market, and of which but little is known of their efficiency and power by thousands who need the power, but lack the necessary information as to what can be done to meet their wants.

With this last point in view, we illustrate some of the leading water motors on the market and their application for small power purposes; together with a table of various water heads and corresponding pressures, with the speed of the periphery of any sized wheel, due to the best effect from any given pressure, or one-half the spouting velocity of the water.

The quantity of water that will flow per minute through the best form of nozzle in sizes from $\frac{3}{16}$ inch to 1 inch, under various pressures, with the corresponding horse power at 85 per cent. efficiency, at which many of the best motors approximate, is carried out in the table, and from which the revolutions of any size wheel may be found by a simple computation.

TABLE OF SMALL WATER MOTOR POWERS.

Head in feet	Pressure lbs	Speed of periphery	3/16" jet galls	Horse power	1/4" jet gall	H.P.	5/16" jet gall	H.P.	3/8" jet gall	H.P.	7/16" jet gall	H.P.	1/2" jet gall	H.P.	9/16" jet gall	H.P.	5/8" jet gall	H.P.	3/4" jet gall	H.P.	7/8" jet gall	H.P.	1" jet gall	H.P.
23.1	10	1155	3.1	.015	5.53	.027	8.58	.042	12.45	.062	16.95	.084	22.12	.11	28.0	.129	34.6	.17	50.	.248	67.8	.336	88.5	.43
34.6	15	1422	3.79	.028	6.76	.05	10.60	.079	15.20	.102	20.76	.154	27.05	.20	34.22	.255	42.2	.31	60.9	.454	82.7	.616	108.1	.80
46.2	20	1632	4.45	.044	7.90	.078	12.50	.129	17.40	.176	24.21	.240	31.64	.31	40.04	.397	49.4	.49	71.4	.71	96.7	.96	126.5	1.25
57.7	25	1833	4.92	.061	8.78	.110	13.78	.171	19.37	.230	26.16	.333	35.15	.43	44.48	.553	54.9	.68	78.9	.98	107.5	1.33	139.4	1.73
69.3	30	2001	5.40	.080	9.63	.143	15.12	.225	21.70	.323	29.27	.448	38.56	.57	48.79	.727	60.3	.90	86.7	1.29	119.7	1.78	154.1	2.29
81.	35	2166	5.80	.101	10.29	.180	16.25	.283	23.30	.406	31.71	.553	41.42	.72	52.42	.916	64.6	1.12	93.2	1.65	126.3	2.21	165.7	2.89
92.4	40	2307	6.21	.123	11.01	.218	17.37	.345	24.91	.495	33.94	.674	44.29	.88	56.06	1.11	69.2	1.37	99.6	1.98	135.6	2.69	177.2	3.52
104.	45	2454	6.58	.147	11.73	.262	18.41	.412	26.40	.591	35.95	.803	46.94	1.05	59.40	1.32	73.3	1.64	105.6	2.36	143.7	3.11	187.7	4.20
115.5	50	2586	6.93	.172	12.37	.307	19.41	.482	27.83	.691	37.87	.942	49.46	1.28	62.60	1.55	78.3	1.94	111.3	2.76	151.5	3.76	197.8	4.92
127.	55	2712	7.29	.199	13.00	.353	20.39	.557	29.23	.799	39.87	1.09	52.13	1.42	65.32	1.80	81.2	2.22	117.0	3.19	159.2	4.35	208.0	5.68
138.6	60	2826	7.62	.227	13.53	.404	21.32	.628	30.58	.883	41.62	1.24	54.36	1.62	68.30	2.05	84.8	2.53	122.3	3.64	166.4	4.96	218.8	6.46
150.	65	2949	7.91	.255	14.01	.455	22.15	.713	31.76	1.030	43.32	1.39	56.40	1.82	71.49	2.30	88.2	2.85	128.1	4.13	173.0	5.58	225.9	7.29
161.7	70	3063	8.13	.282	14.67	.510	23.00	.800	33.00	1.145	44.92	1.56	58.67	2.04	74.26	2.58	91.7	3.19	132.0	4.59	179.1	6.25	234.7	8.16
173.2	75	3168	8.51	.303	15.19	.566	23.83	.888	34.20	1.26	46.54	1.73	60.72	2.24	76.96	2.87	94.9	3.54	136.8	5.1	186.2	6.94	243.2	9.06
184.8	80	3285	8.79	.338	15.67	.603	24.60	.947	35.36	1.36	48.00	1.84	62.70	2.41	78.36	3.01	98.0	3.77	141.0	5.43	192.0	7.39	250.8	9.65
196.3	85	3390	9.11	.384	16.20	.684	25.09	1.10	36.56	1.53	49.76	2.10	65.00	2.74	82.27	3.47	101.5	4.29	146.7	6.19	199.0	8.40	260.0	10.98
207.9	90	3480	9.35	.418	16.66	.746	26.17	1.17	37.53	1.68	51.04	2.28	66.70	2.98	84.46	3.77	104.3	4.65	150.1	6.71	204.5	9.14	266.9	11.94
219.4	95	3564	9.60	.439	17.11	.807	26.85	1.22	38.58	1.82	52.34	2.47	68.96	3.23	86.64	4.09	106.9	5.05	153.4	7.24	209.6	9.90	273.9	12.92
231.	100	3678	9.84	.489	17.52	.872	27.54	1.36	39.40	1.96	53.73	2.67	70.19	3.48	88.83	4.41	109.6	5.45	157.8	7.89	214.9	10.6	280.7	13.95

Jet columns = gallons per minute. For speed of any size wheel, divide speed of periphery in third column by the circumference of wheel in feet.

The question of the cost of power by the use of small motors where water must be paid for by meter measurement is of frequent occurrence, under the apprehension that quantity of water is all that is required; when in reality the hydrostatic head is the most important factor of economy of power in small hydraulic motors.

In the ordinary distribution of water to dwellings in cities and towns the water taps in street mains are usually of uniform size, $\frac{3}{8}$ inch or $\frac{1}{2}$ inch in diameter, with the house pipes $\frac{1}{2}$ or $\frac{3}{4}$ inch if of iron, and $\frac{1}{2}$ or $\frac{5}{8}$ inch if of lead. The limit of pressure for dwellings in most of the cities and towns of the United States is under 50 pounds per square inch, so that motor jets attached to ordinary faucets in dwellings are limited to sizes under $\frac{1}{4}$ inch in diameter and their useful effect under $\frac{1}{4}$ of a horse power.

It will be seen by inspection of the table that there is a large range of useful power for many purposes with much less than 50 pounds pressure and with jets of $\frac{3}{16}$ and $\frac{1}{4}$ inch in diameter.

For jets not stated in the table or intermediate sizes the amount of water used per minute and its power will be in ratio of the squares of the numerators, with equal denominators of the fractional sizes; as, for example, if a $\frac{1}{8}$ inch is to be used, and with the $\frac{3}{16}$ inch jet column in the table for a known quantity and power, the relative proportion will be $\frac{2^2}{16}$ and $\frac{3^2}{16}$ or as 4 to 9; hence to multiply any quantity and power in the fourth and fifth column of the table by 4 and divide by 9 will give the quantity and power for a $\frac{1}{8}$ inch jet under any of the stated heads or pressures, and in the same manner for a $\frac{1}{16}$ inch jet.

The speed of the periphery of any sized water motor is given in column three, which for best effect is at one-half the spouting velocity of the water from the jet. In order to turn the stated speed into revolutions of any given size motor, it is only required to multiply its diameter in feet or decimals of a foot by 3·1416 and divide the numbers in the third column of the table by this product. For example, with a motor wheel 8 inches diameter its periphery is 0·66 foot × 3·1416 = 2·07 feet; and at 30 lb. pressure per table, the periphery speed is 2001 feet per minute; hence $\frac{2001}{2 \cdot 07} = 966$ revolutions per minute.

If a certain number of revolutions are required, then divide the periphery speed in the table for any given pressure by the required number of revolutions and the product by 3·1416 for the diameter in feet and decimals of a foot.

As the power of a given flow of water is in direct proportion to the pressure, so the position of a water motor should be placed at the lowest point that will allow of drainage for the most economical effect where water is to be paid for, which will be in proportion to the cost of water by meter per 1,000 gallons. The charges for water by meter in the different cities and towns of the United States has a surprisingly wide range, being from $2\frac{1}{2}$ to 54 cents per thousand gallons, the average for the whole being about 25 cents per 1,000 gallons, the lowest being in Maine and the highest in the Southwestern States. In the city of New York the charge is $13\frac{1}{2}$ cents, Brooklyn 10, Philadelphia 6, Baltimore 6, Washington 3, Cleveland $6\frac{2}{3}$, Cincinnati 9 cents per 1,000 gallons.

Where power is required greater than can be economically obtained from the ordinary piping of a dwelling, as for printing presses, ventilating fans, small electric light plants, blowing of organs, coffee mills in stores and the many requirements for more power than can be obtained from a quarter inch nozzle, a special service pipe is necessary of at least four times the diameter of the nozzle for distances of 100 feet or less, and at least five times the diameter up to 200 feet in length from the street main.

In Fig. 1 is shown the smallest sized motor of the Pelton Water Wheel Company, San Francisco and New York, the wheel of which is 4 inches in diameter with jet nozzles of sizes to suit the various pressures and required work, Fig. 2 being a larger size with an 18 inch wheel; the sizes made by this company being 4 inch, 6 inch, 12 inch, 18 inch and 24 inch diameter of wheel, all of which are fitted with the peculiar cup-shaped blades used in the larger sizes of Pelton wheels and to which is attributed their great economy.

In Fig. 3 is represented the general form of the hy-

Fig. 1.

Fig. 3.

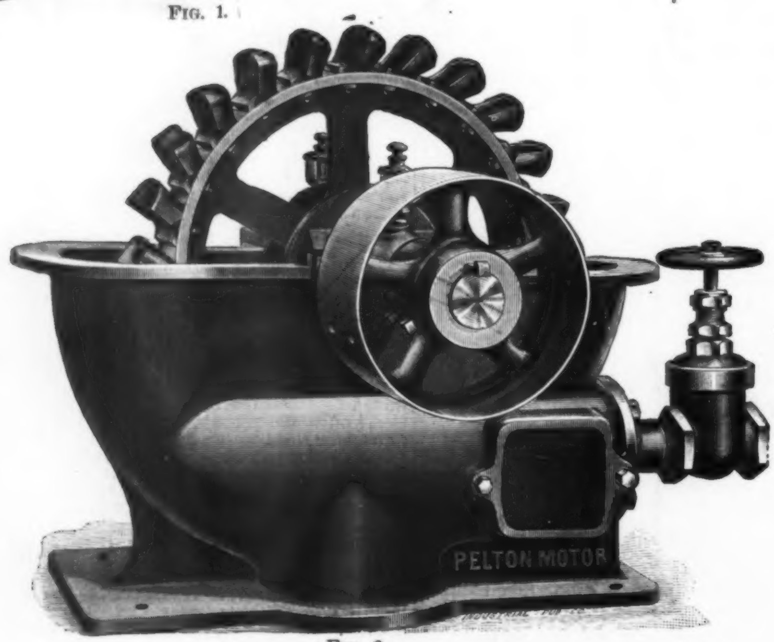


Fig. 2.

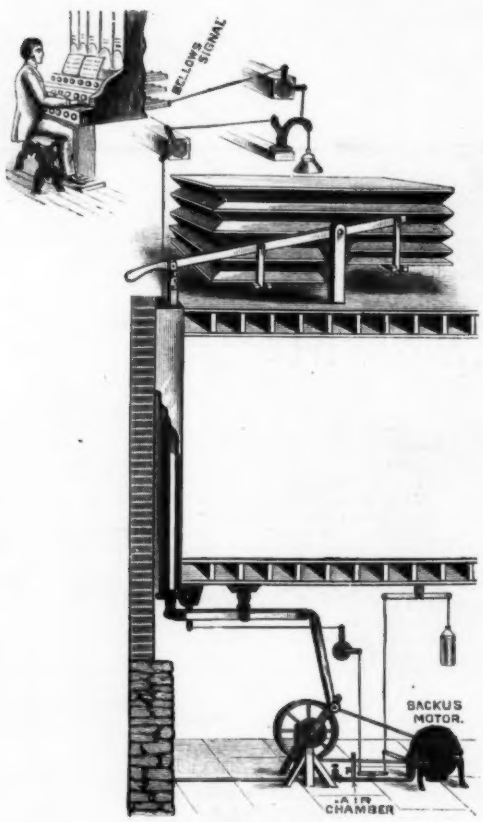


Fig. 4.

WATER MOTORS AND THEIR POWER.

draulic motor of the Backus Water Motor Company, of Newark, N. J. These wheels are made in a number of sizes from 7 to 45 inches in diameter. The 7 and 11 inch wheels being the usual sizes for driving sewing machines, dental lathes, small scroll saws, small fans and the numerous wants for the smallest powers. The larger sizes—12, 17, 22, 30 and 45 inch wheels—are used for driving ventilating fans, coffee mills, printing presses and the blowing of church organs; Fig. 4 showing the method of its application for this purpose. The details of the arrangement for starting and stopping, as also the regulation, are fully shown in the cut.

The Backus Water Motor Company also make a hydraulic or water engine (Fig. 5) especially adapted to the blowing of organs, the method of application being shown in Fig. 6, with the arrangement for starting, stopping and regulation of speed well shown by inspection of the cut.

A unique combination of a water motor and dental grinding and polishing lathe is represented in Fig. 7, and the detail of the wheel in Fig. 8, a late comer to public favor brought out by the Automatic Motor Company, Providence, R. I. It is well adapted for all purposes where a small power is required.

The Tuerk water motor, Fig. 9, made by the Tuerk Hydraulic Power Company, Chicago, Ill., and 237 Broadway, New York, is well adapted for a varying power requirement and high efficiency for any service. Its efficiency being due to a variable area of nozzle, which is regulated by a governor and cone valve, which concentrates the jet at the highest velocity due to pressure, instead of reducing the velocity by an ordinary valve set back from the jet. The sharp cone projecting through the nozzle as the jet is reduced concentrates it to the area due to its pressure velocity and thus insures the highest hydraulic efficiency.

The form and arrangement of the buckets are shown in Fig. 10, and the adaptation of the motor for blowing a four section organ bellows is shown in Fig. 11, with the details of the bell crank movements for starting and stopping, and the automatic regulation of air pressure in the bellows clearly shown.

For the benefit of amateur experimenters with hydraulic motors of the impact type, a word as to the form and position of the nozzle will be in order. The highest actual velocity of a jet of water at the end of the nozzle as compared with its theoretical velocity is the measure of its efficiency. The form of the internal surface has been the subject of much experiment and has finally developed a form of curved cone that gives an efficiency of 97 per cent. in the sizes usual in fire service. The curve is radial with the face of the nozzle and meets a conical form at two diameters back from the end of the nozzle. It is illustrated to an exact scale, together with a table of quantities and horse power of nozzles of the best form and of various sizes from one inch upward, and for hydraulic heads from 1 to 1,000 feet, in SCIENTIFIC AMERICAN SUPPLEMENT, No. 792.

The end of the nozzle should be as thin as practicable and placed close to the periphery of the buckets, pitched downward and tangent to the periphery of the center of the buckets. The size of the buckets, if cupped, should be twice the diameter of the jet radially, three times the jet diameter laterally, and of a depth twice the diameter of the jet. If jet nozzles of different sizes are to be used, then the buckets should be made for the largest size.

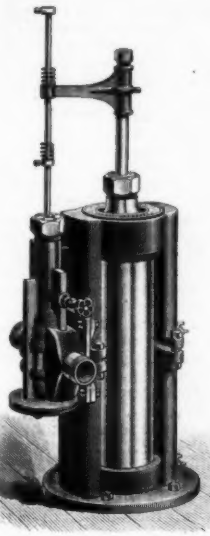


FIG. 5.

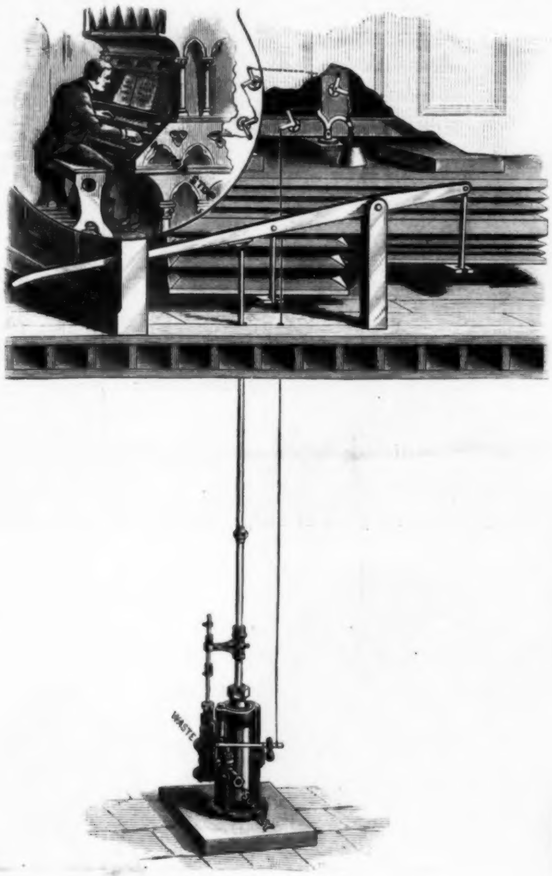


FIG. 6.

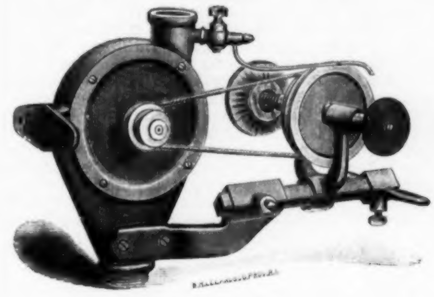
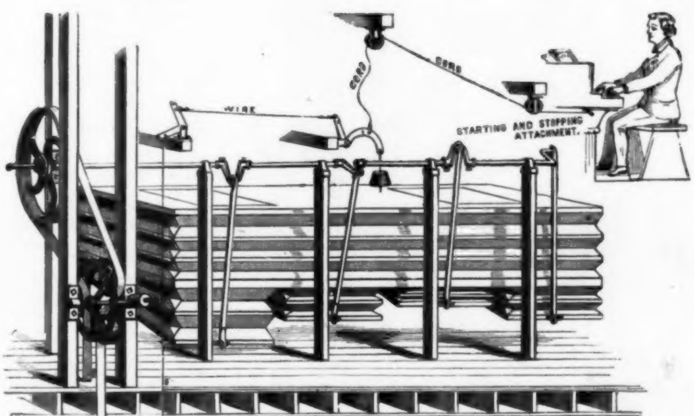


FIG. 7.

FIG. 8.

FIG. 9.

FIG. 10.



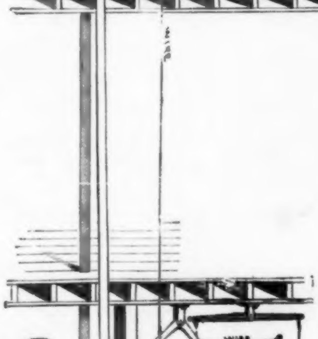


FIG. 11.

WATER MOTORS AND THEIR POWER.

QUICK SHIPBUILDING.

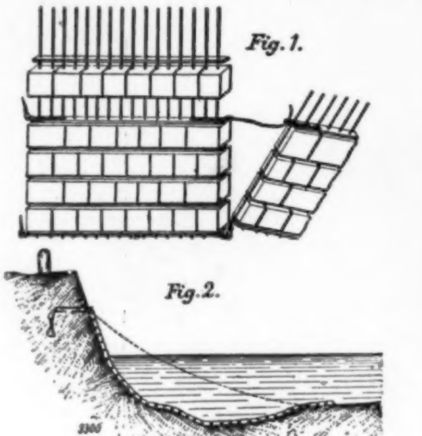
A SAMPLE of quick shipbuilding was lately given by Messrs J. & G. Thomson, at the Clydebank yard, England, where the Paris, New York and many other renowned liners have been built, to say nothing of the Terrible, the first of the two largest cruisers ever constructed in England. Some time ago the Spanish government awoke all at once to the immediate necessity of quashing the Cuban insurrection, and finding that they wanted light, quick vessels, searched the yards of Europe only to learn that the market had been cleared by the South American republics in the settlement of their little differences. There being nothing available "in stock," proposals were invited for quick dispatch, and Clydebank undertook seven gunboats, to be turned out in three months, heavy penalties being recoverable for further delay. The contract was signed on July 11, 1895, but owing to Glasgow Fair holidays, which no Clyde artisan will miss, especially if his firm is exceptionally busy, a commencement was not made until July 22. The first vessel was launched on August 24, and was ready to be taken over on September 11. Others followed in quick succession, the last being completed ten weeks within the contract time, the entire period occupied for completing the seven vessels being just ten weeks—a little less than a vessel a week. The displacements of the vessels vary between 100 and 300 tons, and the speeds from 12 to 13 knots. The first vessel was 136 feet long, 26 feet wide and 11 feet draught. A yard that can

turn out work in this fashion, in spite of having a big cruiser, a battle ship and three torpedo boat destroyers in hand, is, indeed, a source of strength to its country.

Another piece of smart work was executed by Messrs. Yarrow & Company in turning out the sternwheel gunboats Mosquito and Herald, for service in African waters in the British service. England then had a little trouble looming up with Portugal. The order was given on the first day of April, and on May 5 following the trial trip took place, the construction having occupied just twenty-five working days. In the year 1893 the French government found it necessary to give the Dahomeyans a lesson in a hurry. Wanting a shallow draught gunboat for the purpose, they naturally first tried their own native builders, but no Frenchman would undertake to turn out a vessel under four months, some asking ten. They then applied to Messrs. Yarrow & Company, who considered that the thing could be done in a month. They booked the order, commenced work on April 28, and in twenty-three working days, or by May 23, the boat had made her trial. This vessel was 100 feet long by 18 feet wide, and, like the two built for England, was made in portable sections, which could be carried on a steamer and put together afloat. She steamed ten miles an hour and carried 100 troops.—Cassier's Magazine for February.

THE VILLA MANTLE FOR PROTECTING RIVER BANKS.

CAPTAIN EADS was, we believe, the inventor of the mattresses used on the Mississippi to control the erosion of the banks. These mattresses were made of small timber, brushwood, etc., woven together with wire, and sunk over the spot to be protected by loading with stone. Where constantly submerged, such mattresses have proved of excellent service, as, under these conditions, timber will last for an indefinite period. This is not the case, however, when the conditions are such that the mattress is liable to be repeatedly laid dry and again submerged. A form of mattress or mantle not open to this objection has, however, been devised by Signor Giovanni Villa, an Italian engineer, and is now being introduced into England by Villa's Patent Mantle Syndicate, of 5 Rumford Place, Liverpool. As shown in the engraving above, for which we are indebted to Engineering, this mantle consists of a series of perforated bricks or tiles strung on to zinc or other suitable wires, and laid over the bank to be protected from scour. The wires prevent the displacement of the tiles by the wash of the stream, and in a very short time the silt deposited from the river and the growth of vegetation where possible render the mantle an integral part of the bank. The system has already been tested practically on a fairly extensive scale in different parts of Italy. Thus a strip of the bank of the river Olona, near Milan, nearly 1000 yards in length, was dealt with in this way five years ago, and on a recent examination proved in excellent condition. Similar results have been obtained in the case of protection works carried out on the banks of other streams. In particular the French government have adopted it in some works at Bougival, on the Upper Seine. The cost is said to be very low, and the work can be executed very rapidly, as much as 1[illegible] yards being laid per day by one machine.



THE VILLA MANTLE FOR PROTECTING RIVER BANKS.

NEW PUMPING ENGINES, COLCHESTER WATER WORKS.

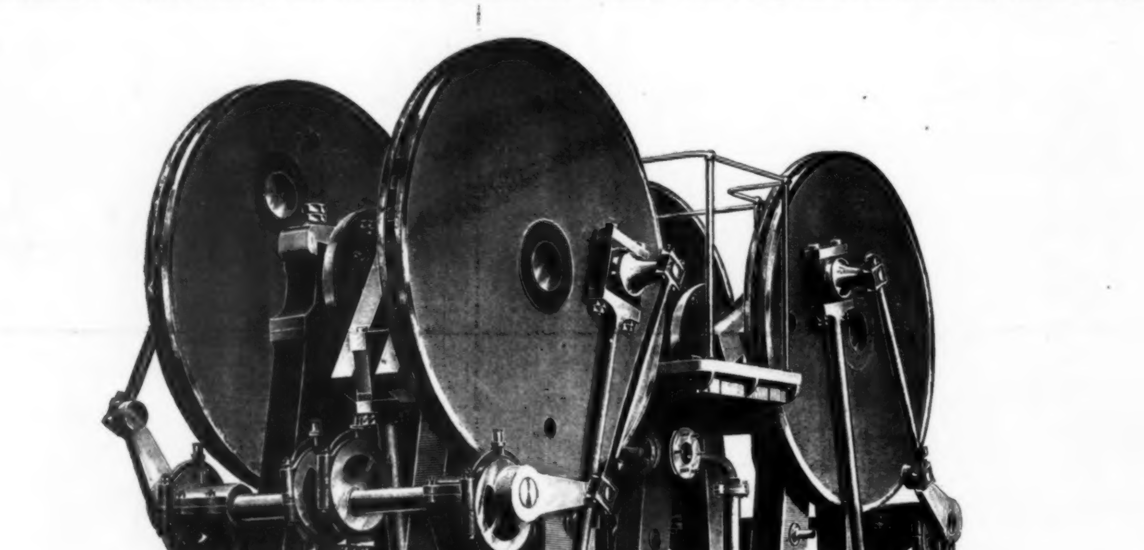
THE new pumping engines of the Colchester Water Works are two three cylinder compound surface condensing, placed directly over the well, each engine capable of pumping 70,000 gallons of water per hour to a total height of 247 ft. The high pressure cylinder is 14 in. in diameter, and the two low pressure cylinders are each 20 in. in diameter, the stroke being 3 ft. The crank shaft is placed over the cylinders, and has two disk flywheels keyed on to it.

The pumps are of the three throw bucket and plunger type, the rods being coupled directly to the tail rods of the steam pistons, each pump barrel being 11½ in. diameter, and having a plunger 8¼ in. diameter. The top box of the pumps is placed 30 ft. below the engine house floor, and is above the standing water level in the well. The barrels are placed 70 ft. below the engine house floor, and are connected to the top box by means of stand pipes supported by strong cast iron girders built into the well above the water level. Each engine is fitted with a separate air pump 9 in. diameter, 3 ft. stroke, and surface condenser having 2[illegible] square feet of cooling surface. The exhaust steam passes through the tubes, and a branch off the delivery main fitted with a sluice cock regulates the amount of circulating water.

Steam is supplied by two Paxman patent economic boilers, 7 ft. 6 in. diameter, 12 ft. 6 in. long, having a working pressure of 125 lb. per square inch, and fitted with feed pumps and injectors. There is one flue in each boiler 2 ft. 4 in. diameter, and seventy 3 in. return tubes the whole length of the boiler.

The well is 80 ft. deep, 13 ft. diameter at the top, lined with 14 in. brick work for a depth of 38 ft.; below this it is lined with cast iron cylinders for a further depth of 30 ft., and the remainder with 14 in. brick work. The standing level of the water is about 30 ft. from the engine house floor.

From an eight hours' trial recently made of the



PUMPING ENGINES, COLCHESTER WATER WORKS.

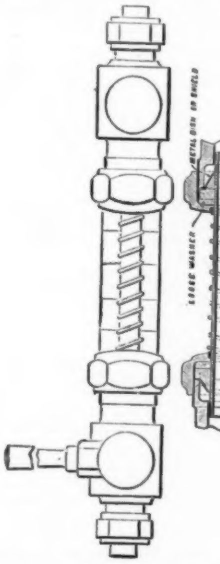
engines and boilers, the following results were obtained:

Mean speed of engines	31·5 revs. per min.
Mean boiler pressure	120 lb. per sq. in.
Mean vacuum	26 in.
Total head of water	235·25 ft.
Mean indicated horse power	107
Mean pump horse power	91·04
Mechanical efficiency	85·09 per cent.
Feed water per indicated horse power per hour	17·77 lb.
Feed water per pump horse power	20.09
Coal used per indicated horse power	1·75
Coal used per pump horse power	2·05
Temperature of feed water	75 deg. Fah.
Water evaporated per lb. of coal from and at 212 deg	12·13 lb.
Foot pounds of work done per cwt. of coal consumed	107,692,848

It will be noticed that the shaft carrying the eccentrics is caused to rotate by two coupling rods from the main crank shaft. The arrangement is quite successful and satisfactory. We are indebted to the London Engineer for the cut and particulars.

GLASS WATER GAGE PROTECTOR.

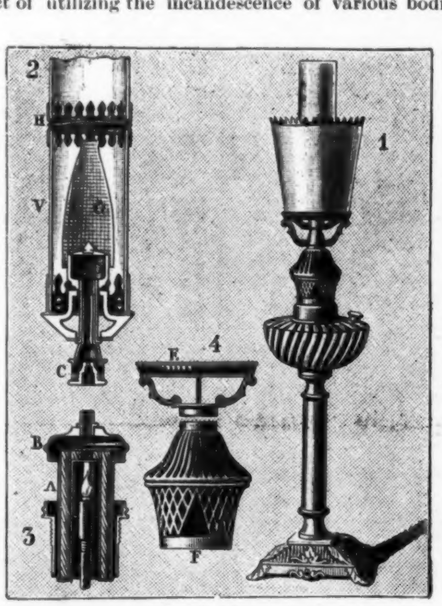
The method employed in protecting the water gage, shown in the accompanying cut, for which we are indebted to Engineer, consists simply in incasing the



outside of the glass with a wire spring, which is held in position by the ends resting in grooves formed in the nuts at the top and bottom of the glass. The wire spring forms a good support or backing to the glass, and when a breakage occurs it holds the pieces of glass together and prevents them being scattered about; it also keeps the glass at a more uniform temperature. As will be seen, as soon as the escaping steam and water have been shut off, the broken glass is easily removed by slightly compressing the wire spring, which may then be taken out of the recesses.

AN INCANDESCENT ALCOHOL LAMP.

Much attention is being paid nowadays to the subject of utilizing the incandescence of various bodies



INCANDESCENT ALCOHOL LAMP.

1. General view. 2. Interior details. 3. Vapor generator. 4. Mounting and globe support.

for lighting. Every one knows the Auer burner and its congeners. All such apparatus have the inconvenience of requiring gas for their operation. Mr. A. Engelfred, who is occupying himself particularly with questions of lighting, and whose holophane globes for diffusing light and throwing it upon the surfaces to be illuminated we have already had occasion to speak of, has just devised an incandescent alcohol lamp which he calls the "callophane burner."

No. 1 of our figure gives a general view of this apparatus. It is a question of an ordinary alcohol lamp with a glass reservoir, above which are the arrangements for the incandescence of which we shall speak. Around the flame is mounted a holophane cone, the object of which is to unite all the luminous rays and bring them to the lower part, in order that they may be utilized under the best conditions.

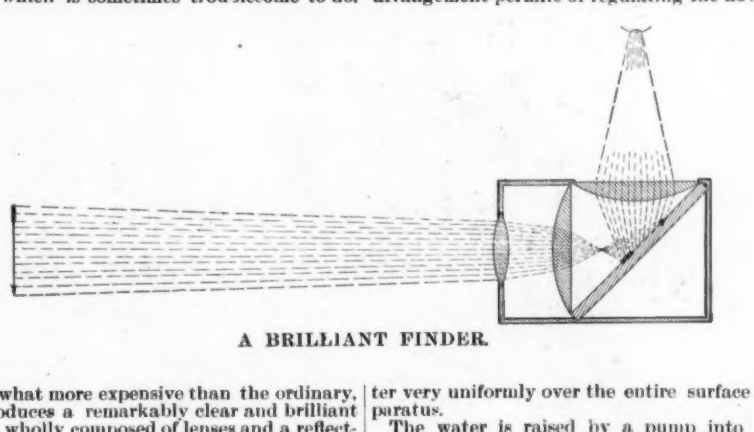
Upon the alcohol reservoir is mounted a cylinder in which are placed four columns, A (No. 3), which end in a dome, B, which they support. Cotton wicks are put into these columns and establish a continuous communication between the dome and alcohol reservoir. In the center there is a small burner provided with a screw with a milled head for regulating the flame. Upon the dome is screwed the burner properly so called, which, like a Bunsen burner, is formed of an adjutage, C (No. 2), with a metallic chimney provided with apertures at the sides and ending at the upper part, at D, in a head that constitutes a support. This latter holds the piece, G, which is carried at its upper part by a hook fixed to a transverse metallic rod. This hook, which is movable, gives elasticity to the movement of the piece, G, in the carriage of the lamp. In order to facilitate the suspension and manipulation of the piece, G, that produces the incandescence, the chimney, V, is formed of two parts that are connected at H. An open work piece, F, with a triangular aperture (No. 4), covers the parts, A and B. Above is placed the globe support, E.

The lamp operates as follows: After the apparatus is completely installed, the small burner is lighted. The alcohol then ascends into the dome, B, through the wicks, and is vaporized. The light may be easily regulated by acting upon the milled head of a screw through the aperture, F. The vapor enters D, wherein it may be ignited. The piece, G, then becomes incandescent and presents a dazzling white light. We have ourselves tried this lamp and have been thoroughly satisfied with the results furnished by it.

Mr. Engelfred estimates that a lamp giving a luminous intensity of 50 candles uses about 60 grammes of alcohol per hour with a recuperating grille. We have endeavored to make some photometric tests, but these are somewhat difficult by reason of differences of color. The ordinary candle, in fact, gives a reddish shade, while the callophane burner gives a very white light. The burner under consideration may be screwed upon any kind of lamp provided with the ordinary screw thread of commerce. The use of it permits of realizing the phenomena of incandescence with a simple portable alcohol lamp.—La Nature.

BRILLIANT FINDER FOR HAND CAMERAS.

The usual single lens, mirror and ground glass, of which most finders are made up, prove to be satisfactory when picture making is made in a strong light, yet even then they have to be shaded with a hood or the hand to make the image appear brightly on the ground glass, which is sometimes troublesome to do.



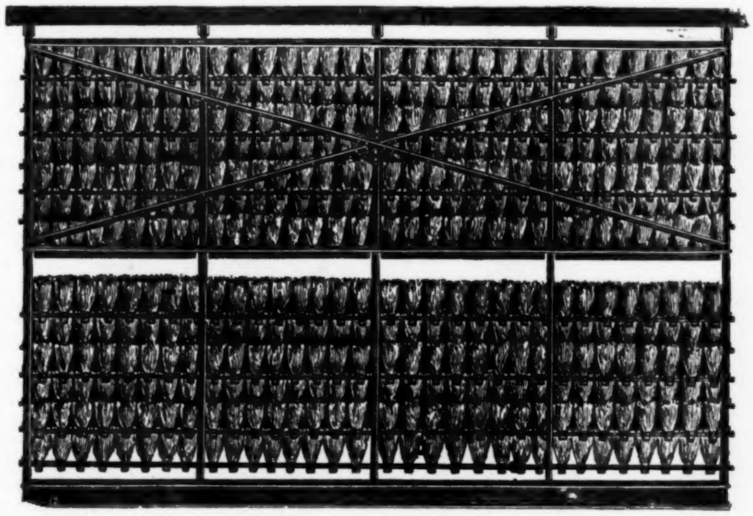
A BRILLIANT FINDER.

A finder somewhat more expensive than the ordinary, but which produces a remarkably clear and brilliant image, is that wholly composed of lenses and a reflecting mirror. One of this kind can now be had commercially, and is very neatly made, the lenses being held in a light metal box. The illustration shows the arrangement of the different parts. A finder, adapted proportionately to a 5 × 7 plate, is constructed of lenses of about the following sizes: Single double convex front lens, ¾ of an in. in diameter and 2 in. focus; a single plano-convex vertical lens, about an inch square and 2 in. focus, and a horizontal single plano-convex lens of 2¼ in. focus. Referring to the diagram, supposing the arrow to represent the object, the rays proceed in parallel lines and are converged by the double convex lens; then, in passing through the single convex lens, are brought through to a focus and cross at point midway between the rear of this lens and the mirror placed at an angle of 45°. The upward reflected divergent rays are taken up by the upper horizontal plano-convex lens and made parallel again or nearly so, and the image is plainly seen by the eye above, as shown. A finder of this character is particularly useful in locations like interiors, woods, caves, etc., where the light is weak, and as the image is free from the grain of the ground glass, it is very clear, visible, and clean cut.

ROHLEDER'S FAGOT REFRIGERATORY.

Mr. A. Montupet has undertaken the construction, in France, of a new fagot refrigeratory, which offers an interesting and somewhat curious peculiarity, and that is that it cools circulating water to a temperature lower than that of the surrounding air.

Since, with similar apparatus, it is possible to cool water only to a temperature approaching that of the surrounding air, manufacturers who consume large quantities of the liquid for the requirements of their motive power, as well as for the manufacture of their products, will be able, owing to the surprising efficacy of this new refrigeratory, to effect a notable annual saving. It will be possible for them to further cool the same water, and, in a corresponding measure, to



ROHLEDER'S FAGOT REFRIGERATORY.

diminish the complement to be drawn from the water distribution of the works. In many cases it will suffice to replace the quantity of water lost through evaporation.

This apparatus, which was devised and patented by Mr. Rohleder, is represented in the accompanying figure. At first sight it does not seem to be very much unlike the fagot refrigeratories constructed of wood, while in reality it greatly differs from them.

The principle upon which its operation is based is naturally the same, that is, the evaporation of the liquid that is required to produce the necessary cold; but the inventor has made an ingenious extension of this principle by submitting the same water to successive evaporations. This operation permits him to obtain temperatures lower than those of the surrounding air.

The apparatus is constructed wholly of iron, so that its stability leaves nothing to be desired. Its length is determined by the quantity of water to be cooled. According as the temperature of the latter is above or below 30°, it is constructed with two or three superposed sections, each forming a refrigeratory, and thus dividing the cooling process into two or three operations.

Above each section there is placed a trough which receives the water, and the bottom of which is provided with apertures, beneath which there are fagots arranged in rows upon metallic crosspieces. A special arrangement permits of regulating the flow of the water very uniformly over the entire surface of the apparatus.

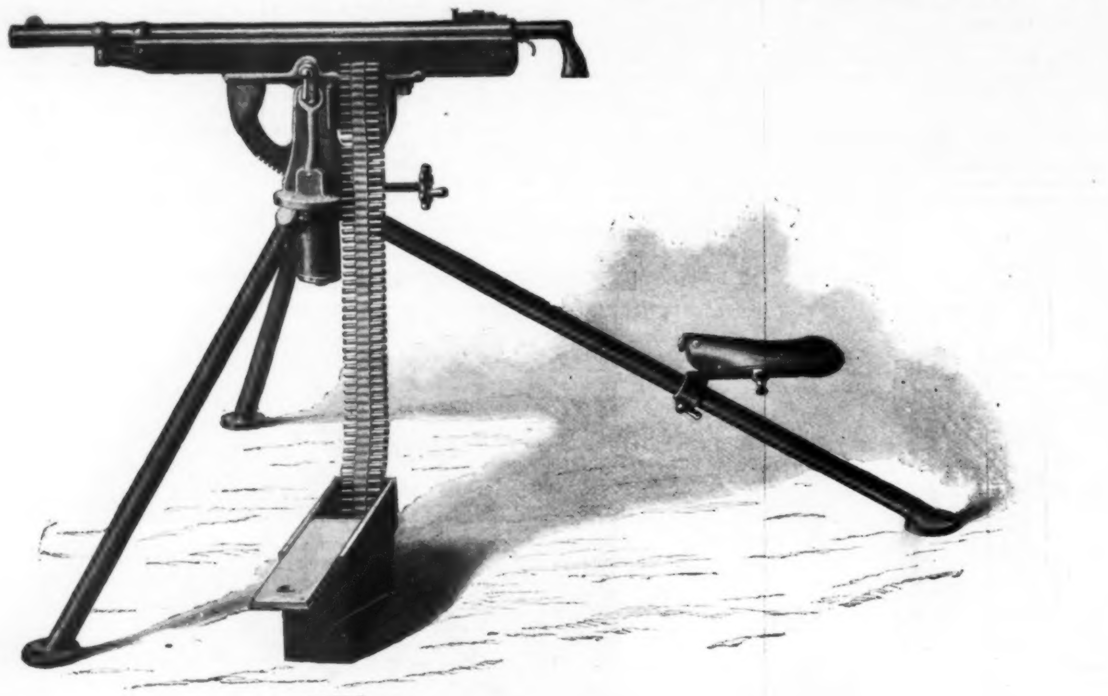
The water is raised by a pump into the upper trough, and thence falls upon the first fagots, whose twigs divide it into very fine drops that form a sort of shower in the intervening space and fall into the succeeding trough. Thence the water is distributed uniformly to all the fagots fixed beneath, and is divided in the same way until it reaches the collector established at the base of the apparatus. In this travel the water is submitted to successive evaporations which produce a gradual cooling of it and permit it to acquire a temperature much lower than that of the surrounding air.

It will be understood that, under such conditions

of operation, the apparatus requires neither attention nor surveillance. With equal power, it occupies much less space than do the ordinary fagot refrigeratories. The maintenance consists simply in replacing the besoms.—Revue Industrielle.

THE COLT AUTOMATIC GUN.

WE present three engravings of the Colt Automatic Gun, which has recently been adopted by the Navy Department after a series of the most exacting tests held under the direction of the Ordnance Board. The

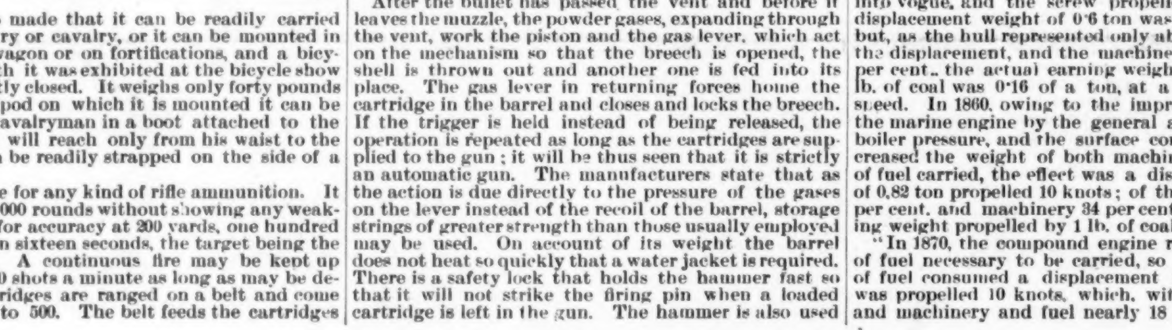


THE NEW COLT AUTOMATIC GUN.

gun is made by the Colt Patent Firearms Manufacturing Company, of Hartford, Conn., under Browning's patent.

The gun is so made that it can be readily carried either by infantry or cavalry, or it can be mounted in a police patrol wagon or on fortifications, and a bicycle equipped with it was exhibited at the bicycle show which has recently closed. It weighs only forty pounds and with the tripod on which it is mounted it can be carried by the cavalryman in a boot attached to the saddle, when it will reach only from his waist to the stirrup, or it can be readily strapped on the side of a pack saddle.

It can be made for any kind of rifle ammunition. It has been fired 8,000 rounds without showing any weakness. In a test for accuracy at 200 yards, one hundred hits were made in sixteen seconds, the target being the figure of a man. A continuous fire may be kept up at the rate of 400 shots a minute as long as may be desired. The cartridges are ranged on a belt and come in boxes of 100 to 500. The belt feeds the cartridges



THE COLT GUN MOUNTED ON PATROL WAGON.

directly into the gun. The gun itself consists of a barrel attached to a breech casing in which is carried the mechanism for charging, firing and ejecting the shells. The belts are coiled in boxes or they may rest on the ground. The feeding will then not be interfered with. When attached to the casing the boxes move with it, so that the vertical or horizontal movements of the gun will not affect the supply of ammunition. The gun is operated by the pressure of the powder gases in the barrel after the projectile has received its maximum velocity; this is done without injuring either its range or its penetration. In the barrel to the rear of the muzzle is a small radial vent, which opens downward from the bore. This is closed by a piston which fits in the gas cylinder that surrounds the outer edge of the vent. The piston is pivoted to a gas lever, so that it adjusts itself to the gas cylinder. The lever swings in a vertical plane. To operate the gun, the feed belt is put in and the lever is thrown down and backward as far as it will go. It is only necessary to do this once by hand. The lever is then released and the spring causes it to move forward, close the vent, and transfer the cartridge from the carrier to the barrel. The same movement cocks the hammer and closes and locks the breech. The shot is then fired by pulling the trigger.

After the bullet has passed the vent and before it leaves the muzzle, the powder gases, expanding through the vent, work the piston and the gas lever, which act on the mechanism so that the breech is opened, the shell is thrown out and another one is fed into its place. The gas lever in returning forces home the cartridge in the barrel and closes and locks the breech. If the trigger is held instead of being released, the operation is repeated as long as the cartridges are supplied to the gun; it will be thus seen that it is strictly an automatic gun. The manufacturers state that as the action is due directly to the pressure of the gases on the lever instead of the recoil of the barrel, storage strings of greater strength than those usually employed may be used. On account of its weight the barrel does not heat so quickly that a water jacket is required. There is a safety lock that holds the hammer fast so that it will not strike the firing pin when a loaded cartridge is left in the gun. The hammer is also used as a piston for an air pump. This forces air into the chamber in the barrel carrying any residue of unburnt powder. All of the working parts of the gun are readily accessible. Owing to its lightness the gun can be handled easily by one man, the operation of the gun being practically like firing a pistol. The gun will prove of great value for police use, as the gun can be put in place in a patrol wagon while the wagon is making its run to a riot. The government has recently given a large order for these guns.

THE PERFORMANCES OF OCEAN STEAMSHIPS.

AT the opening meeting of the Liverpool Engineering Society, an interesting address was delivered by the president, Mr. Arthur J. McGinnis, M. Inst. N. A., on "The Performances of Ocean Steamships." In the course of his remarks, Mr. McGinnis said:

"In 1840, for 1 lb. of coal consumed per hour on a sea going steamer, a displacement weight of 0·578 ton was propelled 8 knots per hour, of which the hull represented 40 per cent. of the displacement, and the machinery and fuel 50 per cent., so that the actual earning weight transported by 1 lb. of fuel was 0·057 of a ton. In 1850, when iron sea going vessels came into vogue, and the screw propeller was adopted, a displacement weight of 0·6 ton was propelled 9 knots, but, as the hull represented only about 33 per cent. of the displacement, and the machinery slightly over 40 per cent., the actual earning weight transported by 1 lb. of coal was 0·16 of a ton, at a slightly increased speed. In 1860, owing to the improvements made in the marine engine by the general adoption of higher boiler pressure, and the surface condenser, which decreased the weight of both machinery and quantity of fuel carried, the effect was a displacement weight of 0.82 ton propelled 10 knots; of this, the hull was 33 per cent. and machinery 34 per cent., so that the earning weight propelled by 1 lb. of coal was 0·27 of a ton.

"In 1870, the compound engine reduced the weight of fuel necessary to be carried, so that for the 1 lb. of fuel consumed a displacement weight of 1·8 ton was propelled 10 knots, which, with hull 32 per cent. and machinery and fuel nearly 18 per cent., left 0·9 of a ton earning weight. During the decade 1870 to 1880 a gradual separation of the passenger and cargo steamers was commenced, which renders it necessary to consider them independently from that date. Taking the cargo boats first, the result is that, in 1880, the purely cargo steamer represented 2·1 displacement tons propelled 10 knots, and as the hull weighed 32 per cent. and machinery and fuel about 18 per cent., a net earning weight of over 1·05 ton was propelled by 1 lb. of fuel.

"In 1890 a marked improvement is to be noticed, as by this time the steel hulls and triple expansion engines had become universal, with the result that the cargo boat represented 3·33 displacement tons propelled 10 knots, the hull representing 30 per cent. and machinery 12 per cent., leaving the earning weight propelled by 1 lb. of coal at that speed as 1·93 ton. It must also be mentioned here that, besides the lessening of the weight of hull, the form for this class of vessel has gradually altered, being made fuller and fuller, so as to allow of more dead weight being carried, the machinery also contributing to this by the fact that the little more power required to drive the fuller form was obtained without any increase in the weight of machinery, and, again, the increased power was obtained with less quantity of bunker space.

"At the present day (1895) it may be said that the two classes of cargo boats are represented by, first, the ordinary ocean 'tramp,' which, with a coefficient of 0·8, waddles along at a speed of 8 to 8½ knots per hour, representing for 1 lb. of coal consumed a displacement of 3·4 tons, of which the hull absorbs 28 per cent. and the machinery and fuel 12 per cent., so that the earning weight transported at 8 knots is 2 tons per pound fuel. Another class of modern cargo boat is represented by the huge vessels now engaged in the North Atlantic and other trades. These vessels, with a coefficient of 0·72, rattle along at a speed of about 12 knots, representing for the pound of coal a displacement of over 3·14 tons, of which the hull absorbs about 30 per cent. and the machinery and fuel 15 per cent., making the earning weight, carried at 12 knots, 1·7 ton. This difference of nearly one-third of a ton between the tramp and Atlantic cargo boat for the pound of coal shows that to increase the speed, say 50 per cent., a considerable amount more of the displacement will be taken up by the larger machinery and the greater quantity of fuel, and also by the slight increase of hull weight, and this, notwithstanding that the lines of the Atlantic cargo boat are such as to allow of the vessel being more easily driven, so that the penalty for greater speed becomes very marked even on cargo boats.

"The express passenger steamers, however, show more clearly the penalty of speed, as they represent, in 1881, for the pound of coal, only 0·57 displacement ton, of which the hull absorbs about 32 per cent. and the machinery and fuel 40 per cent., leaving an earning weight of only 0·16 ton to be transported per pound of fuel. This, in 1895, has developed into 0·45 displacement ton, of which the hull absorbs 33 per cent. and the machinery and fuel 47 per cent., leaving only an earning weight of 0·09 of a ton per pound of fuel. In other words, for each ton of coal consumed in early days an earning weight of 1,366 tons was transported at a speed of 8 to 8½ knots, whereas now a ton of coal transports 4,760 tons at 8 to 8½ knots in the ordinary tramp, and 4,000 tons at a speed of 12 knots on the Atlantic cargo boat; or, putting it in another way, a ton of coal now propels a mass weighing nearly 13,000 tons at from 8 to 8½ knots, of which more than half, nearly 60 per cent., is earning weight; whereas, in 1840, the ton of coal for the same speed only propelled a mass of 2,050 tons, of which only 205 tons, or about 10 per cent., is earning weight. A slight consideration of these figures will show how advantageous to the world at large has been the gradual improvement of steamships, and one almost wonders how much more can be still done to procure further efficiency, and were it not for the fact that each improvement reduces the field for further advances, it would be almost safe to

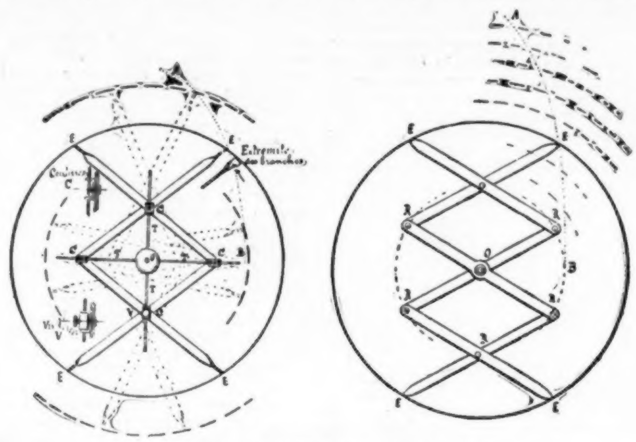
"Looking at the wonderful work done by the naval authorities in the development of 30 knot torpedo boat destroyers, where they have succeeded in obtaining very high indicated horse power from machinery weighing quite 50 per cent. per 1 horse power less than the usual practice of merchant vessels, it can be safely taken for granted that bit by bit the above great factors in obtaining these results, together with the use of costly but exceedingly strong and light materials, will lead to a modification of the existing mercantile practice. Unfortunately, it must be admitted that the present tonnage laws do not tend to encourage the seeking after still further efficiency of the machinery of vessels of the tramp class, owing to the fact of the financial reasons than the scientific and mechanical."—The Practical Engineer.

AUTOMATIC CENTERING COMPASSES.

ONE of our subscribers sends us a description of a small apparatus which we illustrate herewith and of which the name alone will suffice to indicate the utility.

The apparatus may be made of any dimensions, very easily and cheaply, and, despite this, is in no wise inferior, as regards accuracy, to the costly instruments already existing.

It will prove very useful in many industries, and



AUTOMATIC CENTERING COMPASSES.

that even with triple engines it is necessary to provide ample skylight and ventilating openings to obtain the reduction of tonnage allowed for propelling power, as otherwise the increased dues payable would more than swallow up the gain obtained from improved machinery.

"Up to the present the best passage across the Atlantic, from full speed from Queenstown to Sandy Hook, is 5 days 7 hours 25 minutes, which means an average speed of 21·83 knots per hour, and this may be taken as exceeding the average on the year round by about a quarter knot. To obtain this between 28,000 and 30,000 indicated horse power is developed, with a consumption of 500 tons of coal per 24 hours, making a total consumption from Liverpool to New York of 3,200 tons—that is to say, to gain 16½ hours' shorter average power throughout the year, the speed has increased from 19 to 21¼ knots, to attain which it became necessary to increase the daily coal consumption from 300 to 500 tons, say 60 per cent. more.

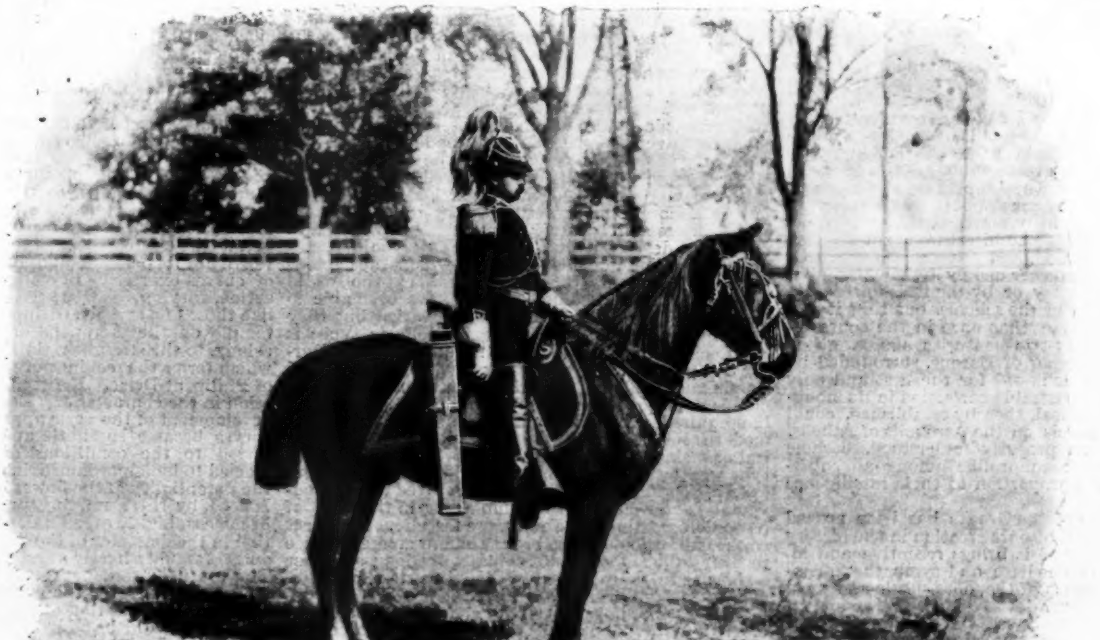
"Remembering the laws of the increasing resistance of vessels at high speeds, according to the present practice it looks as if it would require a prohibitive consumption to increase the yearly average speed per hour to 23¼ knots, which is required to make the outward run in 5 days. True it is, the existing vessels have almost attained this speed on their trips in smooth water, and that 22½ knots have been maintained for

especially in mechanical construction and boiler making. It automatically centers all circles whose diameter is comprised between the dimensions of the short and long axis of the elliptical curve, A B, described by its free extremities.

The apparatus with six branches represented to the right is more especially applicable to the measurement of wide diameter, and is therefore made of wood in order to render it lighter. The sole precaution to be taken in the construction of it is that the holes shall be bored at equal distances. The joints, R, are riveted, and the center, O, is formed of a short tube whose edges are spread outwardly after the manner of an eyelet.

The apparatus with four branches represented to the left consists of four strips of wood or metal and of cross bars connected therewith by means of sockets, C, in which each bar is capable of moving with slight friction. One of the sockets contains a locking ring, V, with a binding screw, designed to render the apparatus immovable in any position.

The construction of the cross bar arrangement is very easily effected by boring four diametrically opposite holes in pairs in a thin metallic ring and in fixing the four rods exactly at right angles upon a board, the extremities of the rods entering the ring. It only remains to pour into the latter some molten metal of any kind whatever. Finally, an aperture, O, is



THE COLT GUN FOR CAVALRYMEN.

prophesy that much greater efficiency will be obtained in the near future.

"The design, construction and material of the hulls being now so well known and thought out as to be readily arranged to suit the special purpose and trade for which they may be required, it is to the engines and boilers attention must be turned for further advance, and here a wide field presents itself in the gain obtainable, in the shape of high piston speed, multiple expansion engines and the water tube boiler.

a whole day in regular work at sea; but the problem to be solved is so vast that it is no wonder a stop has, for the time being, been put to the production of fresh Atlantic liners. Should, however, any of the wonderful results obtained by the naval service become available, then it is to be hoped commercial enterprise will once more launch another 'record breaker;' but that a vessel capable of averaging 5 days across the Atlantic all the year round will be produced in this century does not seem likely, more on account

formed at the intersection of the two lines in order to serve as a center.

The cross bars may be cylindrical, of square section or half flat, and besides, may be provided with a graduation giving the measurement of the centered circle.—Revue Universelle.

MUNICH is to derive 6,000 horse power for various purposes, by electricity, from the river Isar.

CLASSIC ARCHITECTURE.*

FROM THE POINT OF VIEW OF AN ARCHITECT. A DISCOURSE BEFORE JOHNS HOPKINS UNIVERSITY, AT BALTIMORE, MD.

PRIMITIVE or barbarous nations, being free from the restraints of custom and highly emotional, express themselves spontaneously in song or ballad. The effect of culture is to give form and order to these expressions without necessary loss of poetic fire. In like manner architecture gradually developed from conditions of picturesque liberty among uncivilized races, a liberty which often broke into irregular and unconscious expressions of beauty or power, into the discipline and ceremonious elegance which distinguish the buildings of races which are advanced in civilization. This discipline of architecture has been made possible and is still maintained by the remarkable influence of a certain clearly defined and highly organized system of historical forms, which, though it has by usage become arbitrary, artificial or conventional, has asserted itself with powerful insistance, and may be recognized, not only in general effects of symmetry and balance of parts, in a certain air of punctilious formality and self-restraint, but, with infinite variations, in familiar details of cornice or entablature, of piers or pilasters, and in the decoration of apertures and wall spaces. This system still prevails in almost every street of every city of the civilized world.

Though this system of forms has now little or no essential relation to structure, it has been preserved for twenty-two centuries. It has become a sacred tradition, and schools have been formed to preserve and cultivate it. The progress and character of civilization among nations and races through this long historic period is measured by the degree of purity in which this sacred tradition has been maintained. When civilization declined, it was debased; in the dark ages it was forgotten; it was revived with the revival of learning; when civilization has been most highly illuminated, it has become a cult. Every nation, and, indeed, every reign since the establishment of the Renaissance, has unconsciously used this tradition in its own way; has enlarged it or modified it to suit its own material conditions or to express its own characteristic spirit or genius.

This system of forms has thus been subjected to the same formative conditions as language, and it has by these enlargements become capable of expressing various moods and fashions of thought in terms of architecture. Efforts have been made in modern times to prove by reasoning that this cult is a mere superstition, that it is an arbitrary impediment to the rational development of style, and to replace it with some other system of forms more logical and less arbitrary. The Gothic revival of the earlier half of the nineteenth century is one of these attempts. This and all the other romantic revivals of the century have thus far only succeeded in enlarging our vocabulary of forms. They have not supplanted, as yet, that older system which, however conventional, has so grown with the growth of the human mind, is so involved with the history of our race, that it must still be accepted as the basis of architectural speech.

This system of forms, which has survived through such vicissitudes and has had a career so prodigious and so prolific, is classic architecture.

When, through the generosity and public spirit of my professional brother and friend, your fellow citizen, Mr. Wyatt, I had the honor of receiving an invitation to discourse before this university and its friends on this subject of classic architecture, it seemed to me that the time at my disposal, inadequate for the proper discussion of so great a theme, should be used, not in a vain attempt to relate its history or to expound its technique—all this is done in many accessible manuals—but in an effort to give you, from the point of view of an architect, some reasons for the extraordinary survival which I have referred to, to point out, if possible, some of the qualities in classic architecture which have enabled it to exercise an influence so profound that all the greatest monuments of architecture have been inspired and continue to be inspired, refreshed and purified by constant reference to it as to the highest authority in our art. I desire to show that the survival of classic architecture is not an accident or caprice of fashion, and that it has not been maintained as a living power merely by the prejudice of archæological pedantry or by the insistance of an organized propaganda in the schools, but that it is a logical result from the fact that once in the course of human history, twenty-two centuries ago, a gifted people in a remote corner of Europe, surrounded by favorable conditions, achieved for the first and only time in history a demonstrable perfection in its monuments, and that the ideal, thereby established, could not sleep upon its laurels on the Acropolis of Athens. This perfection, when properly understood, became inspiration, and has been prolific among all subsequent races in exact proportion to their intelligence and refinement.

As the architecture of the Greeks has been proved to be the highest result of pure creation in the history of mankind, the study of it brings receptive and intelligent minds into immediate and sympathetic contact with the operations of the more subtle and most fastidious intellects ever devoted to the development of form in art. This study sadly misses its aim if it only succeeds in planting the seeds of scholastic prejudice and narrow archæological pedantry. Properly pursued, it not only purifies, inspires and refines the creative instinct, but enlarges the mind and makes it sensitive to every touch of high emotion, not in architecture alone, but in painting, in sculpture, in music and in literature. In fact, it furnishes the most essential elements of a liberal education. Before such an audience as this, therefore, the serious consideration of what is meant by classic architecture hardly needs an apology.

The simplest element of structure known to man consists in laying a horizontal beam upon two separated upright posts. All the architecture of Egypt, Assyria and Greece was based upon this structural formula, distinctive character or style being conferred upon it in each case by the nature of the building material available, by conditions of climate, by religious and political influences, and, above all, by the spirit or genius of the people expressing itself unconsciously in art. As the systems of architecture, which we call styles, are never inventions, but always growths, the styles of Greece must be considered as developments from those of all the older Oriental nations with which it had any commercial affiliations. But the genius of the Greeks was too original and too powerful to be merely eclectic in its manifestations in art or to be content with any amalgam, however ingenious, of foreign styles. Even in their archaic monuments we cannot discover any direct imitation or repetition of what the wandering Greeks had seen in the cities of the Nile or the Euphrates. On the contrary, wherever they went they rather gave than received inspirations. Their earlier structures were naturally in wood, the post and lintel system in its most obvious forms being applied to the closure of their buildings, and when, with the rapid advance of their civilization, they constructed in stone or marble, they reproduced in the nobler material the most characteristic features of wooden construction. The horizontal lintel beam became the architrave or epistyle. The ends of the ceiling beams which crossed the building and rested on the lintel were evident in the triglyphs of the frieze; the spaces between the beams, originally left open for light and air, were closed with slabs, generally sculptured, which we know as the metopes of the frieze; the sheathed ends of the sloping roof beams or rafters, projecting over the frieze for protection, we recognize in the overhanging cornice or corona. All the principal distinctive features of the Doric entablature are thus simply accounted for. Some of the earliest Hellenic monuments in marble, notably certain Lydian tombs, recall the wooden prototypes very frankly. These prototypes, however simple and unaffected, belonged to the heroic period of Greece, and having been sanctified by religious associations and by ancient usage, were preserved in their later monuments as an instinctive expression of loyalty to national traditions. No intelligent man has ever found it necessary to invent a new language for the adequate expression of his inspirations, and no true artist ever wasted his energies in a vain attempt to invent a new style of architecture. Indeed, a style of architecture is only the unconscious shaping of traditions to meet new conditions of life and thought.

To this instinct of loyalty to traditions may be attributed also the Hellenic custom of covering the pure white marble of their temples with pigments of contrasting tints in imitation of the color effects produced by the necessary application of preservative coats of paint to the wooden originals. The color effects seemed to them inseparable from the forms of the ancient monuments and were instinctively preserved even when the material used was in itself durable and beautiful and no longer needed such protection. Ingenious attempts have been made in modern times to account for the apparent anomaly of covering Pentelic marble, in part at least, with paint, on the ground that this application was primarily intended to enhance by color certain architectural values otherwise dependent on mere contrasts of unassisted light and shade. We find it impossible to believe that the Hellenic mind, accepting color among other consecrated traditions, failed to apply it with the same unerring judgment, the same fastidious taste that they used in adapting wooden forms to constructions in stone or marble. But it is not probable that they used color primarily because it was esthetically necessary to the architectural scheme.

The American school of classical studies at Athens, established under the wise protection of this university and of other similar institutions in our own country, has already, in competition with the schools maintained there by other countries, done signal service in uncovering the precious fragments of tombs, temples, gateways or propylaea, theaters, stoas and choragic monuments in Greece proper, in the islands of the Ægean, and wherever else on the borders of the Mediterranean restless Hellenic enterprise planted its colonies. Every revelation that is made is a confirmation of the proposition that, though the Greeks in their minor monuments freely experimented with form, as was clearly proved by our own investigations at Assos, in Asia Minor, there can still be traced among these crumbling remains a perfectly reasonable, steady and unaffected development of form from archaic beginnings to a point of achievement to which the experiments and studies of the greatest artists in the world during all the succeeding centuries have been able to add no new perfection. They have varied but they have never improved the supreme Hellenic type; it still remains to us the ideal of tranquil beauty. During this period of growth Greek civilization remained simple and made no complicated or embarrassing demands upon the ingenuity of the architects. Domestic life required no costly mansions, and palaces, in the modern sense, were not suggested either by the political or social system of the Greeks. The architectural type was not expanded or diverted to meet new and exacting conditions of living, but enjoyed the vast advantage of development on simple lines in the midst of a people becoming more and more fastidious in respect to the expression of pure beauty and aristocratic grace in their public monuments. This expression was rather serious than sumptuous, for the succession of monuments which most clearly marked the progress of architecture was not in the service of civic or of secular, but of religious life. Thus we have at first the simple cella or room, containing the image of the god; then a portico was added, formed of two columns standing in a front recess of the temple, like those of the tomb at Beni Hassan on the Nile, generally supposed to be the prototype of the Greek Doric shaft; the type was presently expanded into the prostyle temple, decorated in front with a row of four, six or eight free standing columns; then the interior of the temple was divided into two rooms requiring a corresponding portico in the rear of the temple, which thus became amphiprostyle; finally, as wealth increased, the gods were more worthily enshrined in greater and longer temples with various interior subdivisions for a more complicated worship and a higher ceremonial, and these temples began to have columns, not only on the front and rear, but on the sides of the exterior, thus completely inclosing the cella with a peristyle or open screen to protect and make precious the abode of the god. Later there were added for a more majestic approach to the sacred place a double range of columns in front, and thus, finally, was evolved the type which expressed in terms of architecture the highest civilization of the Greeks. In this way the Greek artist, undiverted by any such embarrassing complication of requirements as confront us in more modern days, too intent upon the harmonious development of his own style to be attracted by those of other nations, was enabled to concentrate his activity and intelligence on the evolution of detail. The hieratic theme was too sacred to be trifled with, and it was maintained to the end in simple and majestic integrity.

In all the temples the columns supported an entablature composed of three elements, which were derived originally, as we have seen, from wooden construction, and which, following the Latin method, we call the architrave, frieze and cornice. Each of these was subdivided into certain minor parts which had definite and recognized relations to the whole. By a process of patient and minute experiments, carried on in successive temples, these major and minor divisions of the entablature were subjected to delicate variations in the efforts to achieve perfection in proportion and in the expression of function. The profile and proportion of every moulding were studied with a fastidious care, and modeled with the utmost subtlety and delicacy of curvature; certain of them began to receive conventional decorations in color or sculpture, or were broken vertically into dentals in order to introduce elements of contrast into the composition and to confer such a degree of elegance and richness upon the composition as it could bear without loss of purity and repose. The extreme fineness and brilliant whiteness of the material in which they worked and the wonderful clearness of the atmosphere of Attica encouraged this supreme finish of detail. The perceptions of the artists, trained to a high degree of sensitiveness, noted that the broad shadow of the overhanging corona thrown upon the surface of the frieze beneath, was broken by a series of horizontal half lights and reflections, made by the mouldings which were covered by this shadow. These horizontal contrasts of light and shade, broken by the regular vertical recurrence of dentils and triglyphs, were provided for in the study of profiles with such delicacy that the sun as it touched the marble monument seemed to extract from it harmonies far more subtle than any evolved from Memphian colossi.

This cultivated sensitiveness of perception was applied to the evolution of the column with remarkable results. The Greek artist observed that the marble shaft, as originally developed from the prototype of the dressed tree trunk, though it was structurally able to perform its functions of support, did not seem to be able to do so with that ease and elegance necessary to the satisfaction of his eye. A cylindrical form diminishing regularly from base to summit appeared, by an instinctive defect of vision, to have a slight inward curve which weakened its structural expression, and deprived it of energy. This obvious defect he corrected by modeling it with a slight outward curve or swell, which is called the entasis; this curve, like that of a muscle in effort, conferred upon the shaft a certain movement which immediately elevated a mere mechanical feature into the domain of art. He observed also that the light, as it fell upon this shaft of circular section, made a shade upon it of such gentle gradations from light to dark that it still seemed to need an adequate expression of power, which was ingeniously supplied by cutting the smooth surface into a series of vertical channels or flutings, which not only broke up these too gentle gradations of shade, but repeated the fine curve of the entasis in exquisite variation.

Interposed between the vertical shaft and the horizontal entablature there was originally a plain square block, called the abacus. In the process of this development of structure into architecture, which we are now following, it was early discovered that this transition between supporting and supported members was far too abrupt, too coarse to meet the condition of design at this most important point in the architectural scheme. So the fastidious Greek presently began to interpose between the top of the shaft and the abacus a moulding of support, developed from the round surface known as the echinus. The experiments made in successive structures in the evolution of this most interesting feature in Greek architecture betray the extreme anxiety of the artist to make it worthy of its position and function. It was a study of curves expressive of various degrees of energy in action, varying infinitely from soft under-cut outlines, like those of a crushed cushion, as in the capital of the temple on the Acropolis of Selinus in the Sicilian colony, to the straight rigid lines of the inverted cone which forms the echinus of the capital in the portico of Philip at Delos. Between these extremes the variation in the character of this curve is infinite. As the development of the style approached perfection these curves became so subtle and were so delicately adjusted to the conditions of proportion that they seemed to be foreordained in the base of the shaft, as the potentiality of the flower is in the root of the plant. Indeed, by these refining processes, the architecture became so highly organized, so sensitive, that a variation in the diameter of the shaft or in its height or its entasis would directly affect the curve of the echinus. This mutual interdependence of parts became so complete that gradually the entire structure grew into an organic unity like that of the human body.

Nothing could be added to it or taken away from it without a shock to the entire system. This was not a mechanical unity, like that of a watch or a locomotive, but of a living unity or organism, affected by conditions of material, or climate, of surroundings, of size and use. By the operations of these conditions every example, like an individual or a personality, differed reasonably from every other.

In the early part of the present century it was discovered by Penrose, an English architect, after very careful measurements, that the horizontal lines of the stylobate or platform on which the peristyle of the Parthenon rests and those of the entablature which the peristyle supports are all subjected to a slight curvature vertically. It is supposed that this extremely delicate refinement was, like that of the entasis of the column, intended to correct an apparent visual error. In the same service of refinement the axial lines of all the columns of the Parthenon have been found to incline inward slightly, and the diameter of the corner columns was increased so that, when seen from

* By Henry Van Brunt, Kansas City Architect and Builder.

such a point that they were projected against the sky, their outlines might not be so eaten away by the light as to seem inadequate to perform their service with the other members of the peristyle which had the solid cella of the temple for a background.

This organic unity, which I have attempted to describe to you in very brief outline, as a growth out of the physical, social, religious, political and mental conditions of a great people, and not as an accident or an invention, is the Greek Doric style. The decoration of its gables and friezes inspired Phidias to his greatest work in the Parthenon, which must be considered not only the highest and most splendid expression of the Doric style in Greece, but the most perfect ideal of architecture for modern times, and, indeed, for the entire future of the human race, not for imitation, but for inspiration.

In this style the Greeks expressed their native genius most naturally and with the greatest success, for they were a Doric people, and the Doric style prevailed in all their greatest works on the shores of the Mediterranean, not with the tedious iteration of a perfect formula or axiom of architecture, but with an infinite variety of detail and proportion, all loyal to the essential spirit of the style. Its perfection, however, was possible only on Attic ground. The Ionic style, though an Asiatic importation, was so transformed and so elevated by the genius of the Greeks that it became characteristically Hellenic.

The ponderous and heroic majesty of the Doric was not readily adjusted to all the uses of architectural design, and the Greeks, when they desired to use a lighter entablature and more delicate columns, were glad to avail themselves of certain suggestions from the coasts of Asia Minor and Syria. The most important of these suggestions was the use of the helix or spiral ornament in certain Persian and Assyrian capitals, from which the Greek artist with a divine creative instinct developed the Ionic capital. The proportions of the shaft were made more delicate and effeminate than those of the Doric shaft; it was furnished with a moulded base, and the suggestions of the oriental entablature were expanded into the Ionic entablature of three members.

The details differed from those of the Doric entablature, and the whole composition, as was the case with the Doric style, gradually assumed its especial proportions and characteristics, and another organism composed of interdependent and mutually balanced parts was created, lighter and more delicate than the native Doric organism, but capable of even a larger range of expression, from the virginal grace and almost effeminate refinement of the little temple of Wingless Victory before the propylæa of the Acropolis of Athens to the sumptuous splendor of the peristyle of the mausoleum of Halicarnassus, and the portico of Minerva Polias of the Erectheum.

The growth of these two styles was nearly contemporaneous and both were carried to the highest degree of perfection both in spirit of design and mechanical execution. I have tried to make it clear that this perfection was the result of a very deliberate and thoughtful growth. It was less affected in its development by caprice or by undisciplined emotion, or by personal moods than any other form in art history. Like every other style or school of art, the Doric and Ionic of Greece were enriched as they grew, by the creative instincts of great artists. But the Greek artists worked with a sense of high responsibility and in the presence of a people intensely jealous lest their hieratic architecture should receive a stain. With unerring judgment, they rejected every accretion, however poetic or ingenious, which was found not essential to its sublime unity. They strove to make it more beautiful and more perfect by purification and refinement, not, like the ancient and modern barbarians, by intricacy and ornamentation. It was not suffered to grow at will like a wild thing—like the Romantic styles, for instance—but the two religious and heroic systems of forms which had come to them by tradition, were kept chaste and pure as they developed. None of the creations of man have been subjected to study so continuous and so profound. They are therefore the embodiment of intellectual rather than of spiritual or sensuous beauty, and they represent to the modern mind, authority. They have become ideals, from the influence of which civilized man has never been able and probably never will be able to escape. The modern architectural mind has either been overawed by these ideals—has been kept by them in a servile condition of rigid archæological conformity to their technical qualities, and been thus reduced to a state of unprolific pedantry, copying and repeating with unimaginative iteration, or penetrating beneath the outward form, has been able to extract from Greek art its underlying principles, its fructifying spirit, and to apply this spirit as a chastening inspiration to the best and most indigenous work of modern times. This spirit works not for imitation, but for purification, not for conformity or conservatism but for liberty, for reserve of power, for fastidious care, for noble simplicity, for truth of expression. This is a discovery of our own day, the result of a very modern philosophical method of investigation and study. It is only beginning to bear fruit in an architecture which, we trust, will in time become not only technically homogeneous, but adequate to express the complicated, many sided, self-conscious civilization of our own day and place. At present only the most illuminated minds have begun to comprehend the subtle Greek spirit and to apply it to modern architectural demonstrations. But eve: the letter, even the apparent form of Greek architecture was a myth until Stewart and Revett began the revelation of it in the last years of the eighteenth century, in their famous work on the Antiquities of Athens. Previous to that time it was known to the world only in a very modified form through the mediation of a far more powerful civilization than that of Greece—a civilization which produced another form of classic architecture to which I now ask your attention.

(To be continued.)

AT a meeting of the Royal Astronomical Society in London, an award was made of the gold medal of the society to Dr. Seth C. Chandler, of Boston. The basis of this award is the remarkable work of investigation by Dr. Chandler in his determination of the laws of the movements of the earth's pole and his researches in the department of variable stars.

OPTICAL ILLUSIONS.

WE give engravings of two optical illusions due to irradiation. The one shown in Fig. 1 was discovered by Mr. J. A. Rennie, one of the draughtsmen in the office of the SCIENTIFIC AMERICAN, while drawing some lines across a wheel. The effect of the radial lines crossing the transverse lines obliquely was to cause the transverse lines to appear curved. The appearance is caused by the spreading out on the retina of the image of the white surface lying in the acute angles. It seems impossible to believe that the transverse lines are straight until they are looked at lengthwise.

In Fig. 2 the illusion is produced by laying a white card on a ruled card at a certain angle.

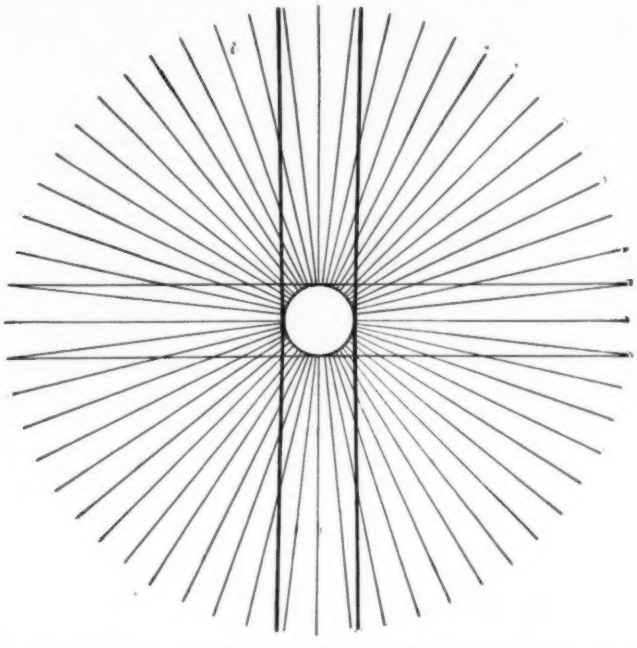


FIG. 1.—OPTICAL ILLUSION—RADIAL AND TRANSVERSE LINES.

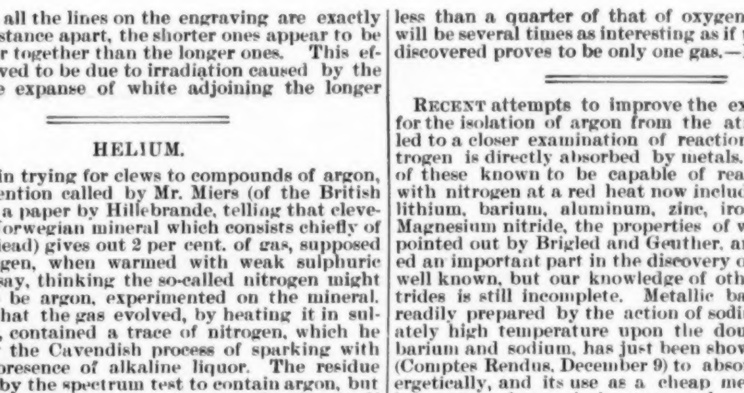


FIG. 2.—OPTICAL ILLUSION—PARALLEL LINES EQUALLY SPACED.

Although all the lines on the engraving are exactly the same distance apart, the shorter ones appear to be much nearer together than the longer ones. This effect is believed to be due to irradiation caused by the considerable expanse of white adjoining the longer lines.

HELIUM.

RAMSAY, in trying for clews to compounds of argon, had his attention called by Mr. Miers (of the British Museum) to a paper by Hillebrande, telling that cleveite (a rare Norwegian mineral which consists chiefly of uranate of lead) gives out 2 per cent. of gas, supposed to be nitrogen, when warmed with weak sulphuric acid. Ramsay, thinking the so-called nitrogen might turn out to be argon, experimented on the mineral. He found that the gas evolved, by heating it in sulphuric acid, contained a trace of nitrogen, which he removed by the Cavendish process of sparking with oxygen in presence of alkaline liquor. The residue was proved by the spectrum test to contain argon, but to contain also another gas, not argon, showing itself by a brilliant yellow line. This line was identified by Crookes as the "helium line," discovered thirty years ago by Lockyer, who finding it to have been not discovered in the spectrum of any terrestrial substance spectroscopically examined up to that time, attributed it to a substance in the sun's atmosphere, which he called helium. Thus, a substance, discovered thirty years ago in the sun's atmosphere, and accordingly named from the sun, has been found in a terrestrial mineral by Ramsay, in his quest after argon. Having got helium into his laboratory, he found its density to be less than 3·9 (ultimately reduced to 2) and, therefore, less than one-fifth (about one-tenth) of that of argon. He sent a specimen to Olzewski, who found (Nature, October 3, 1895) that the treatment by which he had succeeded in liquefying hydrogen, namely, compressing with a pressure of 140 atmospheres, cooling to the temperature of liquid air, boiling at low pressure, and then expanding suddenly, showed no signs of liquefying helium.

Considering the uncertainty as to the density of the gas in which helium was identified, and the multiplicity of spectrums found for it by various experimenters, Lockyer, who experimented on some 80 minerals, and found the yellow line of helium in 16 of them, thinks it most probable that it is not a single gas that is extracted either from cleveite or the other minerals, but a mixture of gases of which helium is one; and this view was supported by Runge and Paschen in their admirable spectroscopic analysis of argon and helium, communicated to the British Association (British Association Report, Section A, September 18, 1895) at its recent meeting at Ipswich. It seems too early to feel sure that the helium found by Ramsay in the gas from cleveite, if perfectly purified of nitrogen and other known gases, is a single gas, or is a mixture or combination of several. Before another anniversary meeting of the Royal Society, it is probable that we shall have certain knowledge, without any doubt, as to this question. Meantime, at our present anniversary, we may be satisfied to feel that if there are several new gases, of which one, at least, has density less than a quarter of that of oxygen, the discovery will be several times as interesting as if the helium now discovered proves to be only one gas.—Lord Kelvin.

RECENT attempts to improve the existing methods for the isolation of argon from the atmosphere have led to a closer examination of reactions in which nitrogen is directly absorbed by metals. The number of these known to be capable of readily combining with nitrogen at a red heat now includes magnesium, lithium, barium, aluminum, zinc, iron and copper. Magnesium nitride, the properties of which were first pointed out by Brigled and Geuther, and which played an important part in the discovery of argon, is now well known, but our knowledge of other metallic nitrides is still incomplete. Metallic barium, which is readily prepared by the action of sodium at a moderately high temperature upon the double fluoride of barium and sodium, has just been shown by M. Limb (Comptes Rendus, December 9) to absorb nitrogen energetically, and its use as a cheap means of preparing argon from air is suggested. Other nitrides have been prepared by a new method by MM. Rossel and Frank (ibid.) Calcium carbide, well powdered and mixed with finely divided magnesium (aluminum, zinc, iron or copper), on heating over a Bunsen burner, with free access of air, gives calcium oxide, together with a nearly quantitative yield of the corresponding nitride. But the most remarkable results have been given by lithium. This metal was recently shown by M. Guntz to absorb nitrogen with incandescence at temperatures below a red heat. It has now been shown by M. Deslandres (ibid.) and M. Guntz (Comptes Rendus, December 16) that this absorption takes place slowly in the cold. The latter exposed about ten grammes of lithium over sticks of caustic soda to a slow current of air; the product, after four months, consisted of seventy-six parts of nitride, twenty parts of hydroxide and only four parts of metallic lithium. M. Deslandres proved the same fact under somewhat different conditions by allowing a confined volume of nitrogen to act on metallic lithium. The absorption was slow, but was so complete that the characteristic bands of the nitrogen spectrum entirely disappeared. M. Deslandres compares the reaction to the slow absorption of oxygen by phosphorus, and points out that, as a reaction of nitrogen, this is unique.—Nature.

STERILIZABLE HYPODERMIC SYRINGE.

THERE is a very large number of hypodermic syringes in the market, and the most recent are taken all apart for cleaning and sterilization.

Our confrere Dr. Mareschal has remarked, however, that they present certain inconveniences that are noticed especially by those who do not use them often, and this is most frequently the case. The apparatus after being neglected for a certain length of time does not work when one has need to use it, because the piston has become hard, and the needle rusty and obstructed, etc.

On another hand, sterilization of the apparatus is too often neglected on account of the complications that it necessitates, such as the disinfecting of the needles by fire, and the passing through boiling water of the piston and parts that cannot withstand the direct action of a flame. Everything that is necessary to perform these operations, notwithstanding their simplicity, is not always at hand.

Our confrere has endeavored to realize a combination which shall, put into the hand of the physician, or of the patient, be an apparatus of small bulk and sure operation, accompanied with the accessories necessary for complete sterilization and for the making of the solutions most employed. During the course of a long campaign in which he has recently served in Madagascar, Dr. Mareschal made constant use of this apparatus, and obtained the best of results from it, and it is for this reason that we make it known to our readers.

It consists of two parallel tubes soldered together (Fig. 1), one of which contains the syringe with its needle, its protecting sheath and the sterilizer, and the other an alcohol lamp, a graduated capsule and a tube for compressed medicaments. Between the two tubes there is a pair of pincers designed for holding the sterilizing tube over the lamp.

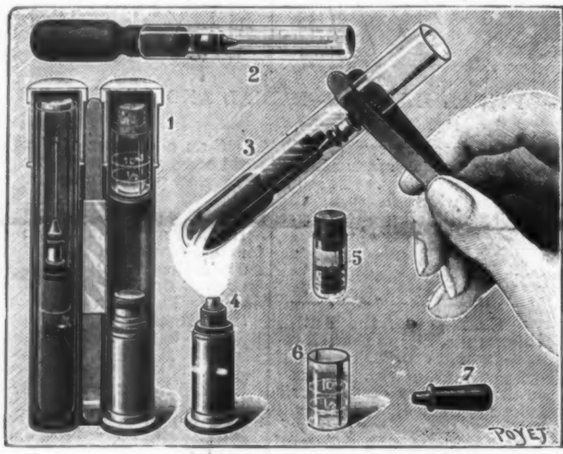
The syringe properly so called consists of three principal elements: (1) a rubber bulb of a capacity of one cubic centimeter, whose tail piece possesses a very narrow channel; (2) an ebonite ferrule, which fits the tail piece of the bulb very closely, and is provided with a central channel and terminates in a nozzle similar to that of the Pravaz syringe; and (3) a needle of the ordinary style.

There are several objections that might be made to this arrangement, especially that common to all rubber objects, which become hard in the long run, the constant humidity of the bulb and consequently the rusting of the needle and the possible development of mould. But Dr. Mareschal remedies all this in a very simple manner by leaving the three elements of the syringe in permanent contact with a two per cent. solution of carbonate of soda, a salt that may be found anywhere. This solution preserves the elasticity of the rubber and prevents oxidation. As for cryptogamic plants, should any appear, they would be destroyed at the moment of ebullition.

When the syringe is not in use, it is filled with the above mentioned solution and is inserted into its protecting celluloid cylinder, which is filled with the same solution (Fig. 2). The whole is placed in the test tube designed for sterilization. At the moment of using the instrument, water is put into this tube, and the bulb, previously emptied, is placed therein, along with the needle. Then, with the pincers and the lamp that accompanies the apparatus, the water is raised to ebullition (Figs. 3 and 4). From the compressed tablets contained in the small tube (Fig. 5) the injecting solution is prepared in the graduated capsule (Fig. 6). The whole thing is done in five minutes. Through these wise precautions, we are certain of avoiding the appearance of abscesses, which sometimes occur without apparent cause and the origin of which is due to a faulty sterilization or to the use of too old a solution.

It is evident that all medicaments cannot be employed in a compressed state; but we find the most usual ones, such as hydrochlorate of morphine, for example, in this form.

The object of the apparatus, however, is not to be universal, and it is not designed to dethrone the Pravaz syringe, which will always be necessary when a definite number of drops or chloroform, fats or turpentine are to be injected; but it will give the practitioner a means of always having about him the material necessary for making the most usual hypodermic injections under the best possible conditions, and under many circumstances, this little apparatus will render him more services than his case of surgical instruments.—La Nature.



DR. MARESCHAL'S HYPODERMIC SYRINGE.

1. Complete apparatus. 2. Syringe and protecting tube. 3 and 4. Sterilization. 5. Compressed medicaments. 6. Graduated capsule. 7. Piece connecting the syringe and needle.

THE OYSTER SHUCKERS' EYE DISEASE.

DR. ROBERT L. RANDOLPH has in the last issue of the Johns Hopkins Hospital Bulletin an article which treats of the so-called oyster shuckers' keratitis; its causes, symptoms, the mode of treating the disease, and a clinical and experimental study of the disorder. Oyster shuckers' keratitis is defined as a traumatic keratitis, where the injury is produced by a particle of shell striking the corner of the eye, and embedding itself in that organ. The extent of the injury does not explain the violent reaction which follows. Baltimore is the greatest oyster market in the country, and the tenth census of the United States shows that there are at least 6,000 shuckers in Maryland, most of them being in the shucking houses of Baltimore. In many of the Northern cities, including New York, Boston and Portland, oysters are received in great quantities that have been shucked in that city, so that oyster shucking in those cities does not exist as a trade to the extent that it does in Baltimore. The magnitude of the oyster industry in that city may be said to account for the frequency of the oyster shuckers' keratitis there. The reports of the eye hospitals in Baltimore contain the records of several hundred cases during the last few years, and during the last several months twenty-four cases have been treated at the Baltimore Presbyterian Eye and Ear Hospital.

A NEW CABBAGE PEST.

THE cabbage maggot, the larval form of a fly, Anthomyia brassicæ, is the most destructive pest of the cabbage in Europe, where it sometimes destroys whole fields of young plants. It has been occasionally troublesome in the United States since 1846. It has the past spring appeared in alarming numbers in a portion of the trucking section of North Carolina.

The fly is slender and gray colored, rather smaller than the common house fly. The female lays her eggs in early spring on the roots or stem of young plants, both in the seedbed and field. The eggs hatch out in about five days. The maggots eat off the young rootlets, producing what is often called "club foot;" they also bore into the larger roots and stems, causing the plants to turn yellow and soon after die, or remain as stunted plants which refuse to head. The flies continue to breed all the summer and pass the winter as dormant pupa in the hollow stems of cabbage and stumps, if left in the field. Some of the winged insects also hide away in cellars and places where cabbage is stored, but the greater portion of the first brood of flies come from the dormant pupa in the field. The maggots feed by preference upon the roots of cabbage and other cruciferous plants—collards, kale, cauliflower, radish, mustard, etc.; but they breed also in stable manure piles, human excrement and rotten fish.

REMEDIES.

The first and most essential remedy is to clean cabbage fields thoroughly of stumps. Either plow these under at least six inches deep and then roll the ground or gather the stumps and compost them with lime. Never follow cabbage by the same crop on any field. If the maggots appear on plants in the seed bed, apply a good dressing of lime or muriate of potash to the soil, or sufficient kerosene emulsion to wet the ground one inch deep. If plants in the field are attacked, take a dibbler or sharp stick and make a hole near each plant as deep as the roots of the plant and about one inch in diameter. Fill this hole with kerosene emulsion. If the emulsion does not wet the soil on all sides of the plant, make and fill another hole on opposite side. Usually, one treatment will be sufficient for each crop, but if neighboring fields are left untreated, they will breed flies so fast that a second treatment may be necessary after ten days. The emulsion must be thoroughly made. But it will be safe in any case, if it is not allowed to touch the leaves of the young plants.

THE KEROSENE EMULSION.

Hard soap, ½ pound.
Water, 1 gallon.
Kerosene oil, 1 gallon.

Directions.—Shave the soap and boil till all dissolved in the water. Remove from the fire and pour into the kerosene. Churn this or pass it through a sprayer or syringe until it becomes a thick cream and the oil does not separate from the soap. Dilute with nine times its bulk of cold water before using.

This remedy is equally as good for the onion maggot, cut worms and all other burrowing insects. When thoroughly made it will not burn the plants, but if any free oil rises to the top, it will burn.—Gerald McCarthy, Entomologist, N. C. Experiment Station.—Southern Planter.

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